GENERAL PSYCHOLOGY

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General Psychology

By

WALTER S. HUNTER

Professor of Psychology, University of Kansas

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PREFACE

To some of us the preface of a textbook is one of the most interesting of its features. There the author puts aside his air of instruction and authority, lays bare his hidden complexes, his morbid fears, and erects defense mechanisms against the many critics that of course his work must find. In the present instance I have adhered closely to the subject-matter and method which have proved successful in my own semester courses. I have found that students desire more than general formulas and principles. They are far more interested in accounts of experimental facts and procedures and are willing to leave the other for the manuals of advanced students. (The actual student, of course, is willing to leave it all to someone else, but since he must choose I find that he prefers the concrete facts.) The present book seeks to meet this situation and still remain a textbook and not become a treatise. It has been written in the conviction that too much stress is placed upon normal adult psychology (pure psychology) in our introductory courses. In many if not in most cases these courses are meant by the department and college administrations to give a comprehensive view of the field as well as to furnish specific training in the science. This demand is not only sound from the point of view of culture, but it is important in the resulting view of the science. Psychology is far more than normal adult psychology. Yet many of its readers retain the impression that the chief topic is sensation and space perception. The present book seeks to forestall these misconceptions in the student by presenting a general survey of the science while still stressing the customary side of the subject. In my opinion this procedure becomes still more valuable when it is remembered that the

great majority of students acquire all of their technical psychology from the introductory courses. The chapters of Part I are not intended as complete summaries of the respective fields concerned. They seek rather to stress typical problems illustrative of the scope of psychology. The chapter on "Animal Psychology" is unfortunately the least well-rounded and comprehensive because much that might be written there has been deferred to Part II, where the topics of instinct, habit-formation, and association are discussed. The book is so arranged that, in teaching, Part I may either precede or follow Part II. Whichever method is used, one is certain to see merit in the alternative procedure. My own experience favors the sequence as given in the text. To take up "Animal," "Individual and Applied," "Abnormal," and "Social and Racial Psychology" first is to secure the student's interest at once, if it can be secured, through a study of the very concrete and the practical. It is true that if these topics came last in the course they might be more adequately understood; but the same thing is true for "Normal Adult Psychology," with the added reason that practically a teacher is so hurried at the close of the semester that topics left for the last are often slurred over and telescoped. In using the material of Part I in a semester course I have contented myself with assigned readings and approximately two lectures on each chapter. This can be elaborated more fully in longer courses, and in shorter courses Part I can be used as outside reading matter with Part II the subject for lecture.

From the theoretical standpoint our position is one of a combination of behaviorism and structuralism. I see no need for forcing the subject-matter into one or the other mold. Neither is large enough alone. Psychologists study both consciousness and behavior that does not involve consciousness. Functionalism seems untenable unless one assumes that mind affects the body. It played its great rôle by stressing biological factors until behaviorism could appear upon the scene. If, on

the other hand, one must weigh the respective merits of structuralism and behaviorism, the latter I think has the advantage. Our problem, however, is not so much to state everything in objective (behavioristic) terms as it is to supplement the introspective account with data upon environmental adjustments irrespective of the conscious qualitative content. It is well and important to know that such and such an act of reasoning, of delusion, etc., *can* go on in terms of auditory images or of kinaesthetic sensations; but it is of far more value to analyze the process of success or failure.

It is a pleasure to acknowledge the influence upon this book of the teaching of Professors James R. Angell, Harvey Carr, and John B. Watson, and of the writing of Professors James and Titchener. My wife, Alda Barber Hunter, has given most valuable aid in the actual preparation of the manuscript.

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Walter S. Hunter

Lawrence, Kansas
May 1, 1919

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INTRODUCTION

INTRODUCTION

The Subject-Matter of Psychology.—At present attempts to delimit psychology from the other sciences are rarely made with particular seriousness. It is enough to get clearly in mind the general goal to be attained. No growing field of study can be held within the limits of a definition, for it will go wherever its devotees take it! Psychology has always taken as its general goal the understanding of human nature and human behavior. Until the middle of the nineteenth century chief emphasis was placed upon the intellect, and psychology was considered a part of philosophy particularly as related to the problems of the theory of knowledge. As such it was the study of mind, consciousness, or the soul, and the limits of these marked the uttermost boundaries of the science. In 1830 and the years following, however, genuine scientific movements in psychology had their beginnings in Germany, France, and England. In Germany the work was begun by physiologists and physicists, Ernst Weber, Theodor Fechner, Hermann Helmholtz, Ewald Hering, and Wilhelm Wundt. In France the emphasis was upon the study of abnormal mental phenomena. The typical students were J. M. Charcot, Pierre Janet, and Alfred Binet. In England we find yet another type of work in the biological studies of the behavior of man and other animals carried on by Charles Darwin, Herbert Spencer, G. J. Romanes, and others. From these early beginnings first one phase of human experience and then another has come under experimental scrutiny until in the past decade the chief contributions have concerned the nature of thinking and the measurement of "general intelligence" in the various grades of men. With the development of the science has come an increasingly important bearing upon

the practical problems of society, many phases of which will become apparent as our present account proceeds.

It is possible to divide the subject-matter of psychology into two significant classes: the facts of consciousness and the facts of behavior. These two groups of phenomena are most closely related, as we shall see, and yet they are so distinct that separate theoretical systems of psychology have been founded upon them, each denying the possibility of the other. The present account should make clear that the science of psychology, as it is actually developing in the laboratories, involves both classes of data.

The Nature of Behavior.—Our introductory account of behavior may well be brief. By *behavior* is meant *the muscular and glandular activity of an organism*, such, for example, as is seen in fear, in the formation of habits of movements, in speaking, etc. Psychologists study behavior of this type and also such behavior as the variations in breathing and circulation which accompany conscious states of the type of pleasantness, unpleasantness, and attention. Mention should also be made of the important behavior studied in relation to emotions (e.g., the activity of glands of internal secretion) and in relation to hunger (the contractions of the stomach), and of the nature of the nervous processes which control all of them. In the study of these topics psychology comes in the closest possible relation to physiology, zoölogy, and neurology, just as it is closely related to physics in the study of light and sound. However, not all forms of behavior are studied by psychologists. There are some which have only an indirect and very distant relation to the consciousness of the individual, such, for example, as the secretion of pancreatic juice and the mechanics of respiration, and which have also but little effect upon the overt behavior of the organism as a whole. These topics may therefore be termed *purely physiological*, and will remain so until evidence is advanced indicating a relatively intimate connection with

consciousness and the organic behavior of the individual, the *overt behavior* of the organism as a whole.

The Nature of Consciousness.—By a state of *consciousness* we shall understand *anything of which I am immediately aware*—a book, a table, a color, a pain, my hate, a joy, a memory, or a thought. On the other hand, no object of which I am at present unaware is a state of consciousness. Into this class fall things I have never known immediately and also those objects that I have known but of which I am not now aware, such as forgotten pictures and emotions. Every state of consciousness must exist in the present; what is past or future is non-existent. A forgotten idea does not exist stored up in the mind: it is the modifications in the nervous system that remain.

Things as we experience them depend upon the activities of the sense-organs and of the nervous system and not solely upon the physical object. Thus a room may be hot to one person and cold to another, depending upon whether or not the individual has just come from a warmer or a cooler room. Again a person walking toward us is actually affecting the eye as though he were steadily growing larger, and yet what we are aware of is a decrease in distance. These are facts of consciousness, as is also the sort of mental imagery one uses in thinking of a familiar house, whether one has a mental picture or an auditory image of its name.

Consciousness accompanies certain forms of activities in the nervous system. It is, however, not a nervous process, nor is it located in the brain. What science finds in the brain are certain physical and chemical processes, all of which are as different from a state of consciousness such as joy as two existing facts can be. The further description of consciousness must await the development of the body of the present text.

The Methods of Psychology.—The primary methods of psychology are not different from those of other sciences which

require the analytical, experimental observation of facts and events that are vivid and precise at one time though very fleeting and elusive at another. The observation and description of states of consciousness are difficult and require thorough training before expertness can be attained—a condition, however, that is true of the task required of observers in all sciences and in many branches of non-scientific life. An umpire, e.g., in a baseball game must be able to see instantly where the ball has gone and whether or not it gets to first base prior to the runner. So the psychologist must say which of two events precedes and what each one is. If they are sensations—things seen, touched, smelled, etc.—the task may be relatively easy. If they are ideas the difficulty may be very great. Many states of consciousness, such as memories, images, feelings of pleasantness and unpleasantness, are not only vague and confused, but are also fluctuating in character. We can attend to them for a moment, and then they are gone. The difficulty of accurate observation and report is certainly real, but it is not different in kind from that which meets the histologist and zoölogist. When they put structures living or dead under the microscope and attempt to describe what is seen, the lines of demarcation are often faint or the activities of the organism brief, with the result that contradictory evidence is presented by different observers. The solution of the problem then comes only with increased training in observation and with many repeated descriptions, a condition similar to that presented to the psychologist.

The experimental work in psychology consists in so controlling the factors modifying consciousness and behavior—for example, vision and habit-formation—that accurate statements can be made concerning the causes of various features of these two classes of material. This may mean in the former case the control of the amount, size, and duration of illumination and in the latter case the regulation of the complexity of the

habit and of the number of trials per day. These observations must be systematic, controlled, and subject to repetition if they are to meet the requirements of science.

The particular experimental methods that are used in psychology will vary with the particular problems to be studied, as is the case in physics, chemistry, and zoölogy. In our present science there are, for example, the methods of mental tests, of psychoanalysis, of psychophysics, of animal behavior, etc. These methods will vary as much for the different problems within one science as they do from one science to another. It should be insisted that there is no one method peculiar to psychology. It is often urged that *introspection* is such a method. Introspection, when so used, signifies a "looking within" and a "noting of the nature of one's conscious states," as opposed to a "looking outward" and a "noting of external things," which is termed observation. The assumption is here that consciousness is in some manner "within." We have said, however, that consciousness is not in the brain, and observation fails to verify the "inward" as opposed to the "outward" existence of such states of consciousness as colors, sounds, etc. Conscious states may be localized outside the body, as is here the case, or they may be within the body, as is true in hunger and anger. As a result of this possible twofold location of consciousness, the exact use of the term introspection only produces confusion. When met in the present text, therefore, the term will be synonymous with observation, for one need not have two scientific methods merely because the material that one studies may be located in either of two places.

The Fields of Psychology.—Although present-day psychology is concerned with the general problems of consciousness and behavior, there are a sufficient number of different conditions under which the problem must be studied to justify the division of the science into separate fields. These may be enumerated as follows: normal human adult psychology, animal psychology,

social and racial psychology, individual and applied psychology, and abnormal psychology. In addition to these, child psychology, genetic psychology, and physiological psychology are often mentioned. These, however, in our opinion do not deserve to rank as separate fields or divisions of the science. Practically all that is known about child psychology is the result of mental tests. The remainder of the work which has been done (observations, usually uncontrolled, on instinctive development) may well be included with the tests in individual psychology. Genetic psychology is not so much a field as a point of view from which data are arranged according to a scale of complexity or of probable development—that is, we arrange the facts of animal, child, and adult human behavior in a series to indicate their probable order of appearance. Finally, all psychology seeks to correlate consciousness and physiological processes and is therefore physiological psychology in intent. The more all of these parts of general psychology develop the more thoroughly interrelated they become with our ultimate purpose, that is, the giving of a complete account of human nature. On the basis of this developing body of scientific data, a psychotechnique (Münsterberg's term) is growing up which, in addition to contributing purely scientific material, is aiding materially in the solution of many social problems. We shall include certain so-called practical material in the chapters that are to follow.

A more detailed view of the present status of the various fields of psychology, with their special methods of investigation, will be given in Part I, "Fields of Psychology." The discussion of normal human adult psychology, however, will be reserved for Part II, in that this field is usually treated as the major part of psychology. Historically it is the parent stock. At the present time, however, when judged by the central problem of the science as a whole, it has several rivals among the other fields both with respect to exuberancy of spirits and to importance of contributions.

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PART I. FIELDS OF PSYCHOLOGY

CHAPTER I

ANIMAL PSYCHOLOGY

Introduction.—The psychology of the last fifteen years has been particularly characterized by the growth of the objective point of view. This angle of approach to the subject-matter of the science places chief emphasis upon the behavior of the individual and less upon his consciousness. It is much too early to decide between the two points of view. Indeed it is impossible to say whether the objective method has only broadened the science of psychology or whether the advance has been so great as actually to create a new science which still masquerades under the name psychology. It is clear, however, that in the advance two particular fields have led the way, animal psychology and individual psychology. We shall treat the latter in the following chapter.

Animal psychology, or animal behavior as it is now usually termed, cannot deal with consciousness save inferentially because the animals studied cannot introspect and consequently cannot tell us their experiences. This field is therefore the objective psychology *par excellence.* The descriptive terms that are used in treating behavior, such as sensation, memory, imitation, etc., since they are largely borrowed from human psychology and common sense, do have a marked reference to conscious states, but this fact should either be ignored or treated in a hypothetical manner. We need not attempt to decide the question whether or not animals are conscious. They may or may not have a mental life approximately similar to that of man. Certain it is that there are no evidences or criteria by which we may decide that consciousness is or is not present in animals below man. Although the animal's brain, sense-organs, and

behavior may closely approximate man's, still we cannot tell that neural action has crossed the threshold of consciousness. We do not know even in man actually what brain activity is necessary for the appearance of consciousness, because not all brain processes condition it. We shall therefore leave aside all questions concerning the existence and nature of an animal mind and seek a brief introduction to the problems of animal behavior. Here we shall be interested in all reactions of a particular organism as a whole upon its environment. We shall attempt to draw no sharp line of distinction between behavior of a part and behavior of the whole animal, organic behavior; and yet the emphasis will be clearly on the side of the latter problem. Interest in this field is largely due, historically, to the influence of Darwin, Romanes, C. Lloyd Morgan, and the host of naturalists who studied the problem of animal behavior after the scientific advent of the theory of evolution.

The Chief Problems.—The field of animal behavior divides itself into three great topics, the last two of which can really be considered one: (1) the study of sense-organ processes—what an animal can see, hear, taste—and the functions of these processes in the organism's daily behavior; (2) the study of motor and glandular activity—instincts, reflexes, and habits; (3) the study of the higher capacities, as they may be called for convenience—imitation, ideational behavior, language capacities, and the general problem of whether animals think. Under the second division we have the question of learning, its conditions, and types. I may anticipate enough to say that the results obtained here are essentially true for man. The topics under the third division are really parts of the study of habit, for each of these "higher activities" is either a method or condition of habit-formation or a particular way of utilizing the habits when once established. Since, however, the topics here listed are usually associated with so-called higher mental ability, it would not be representative of the status of the science

to classify them without further ado under the caption *motor and glandular activities.*

As a result of the exhaustive study of the above topics, there will accrue at least the following results: (1) Psychology as a whole will become more objective. (2) The essential continuity of human and animal sensory and motor activities (including instincts and habits) will be seen. (3) Light will be thrown upon many aspects of human nature which can be more safely and conveniently studied upon animals than upon man. (4) New points of view concerning human processes—learning, association, ideas, etc.—will arise which will be helpful in normal human studies. Much of this is possible because animal psychology is still young enough or different enough to resist tendencies toward the formation of systems of psychology, a practice which has beset the parent subject.

Methods of Experimentation.—For practical purposes we may say that there are three chief methods of studying animal behavior: (1) the naturalistic method, or method of field observation; (2) the method of general response; and (3) the method of selective response. The first method was used particularly by the naturalists of Darwin's day. It is still used for practically the same purpose, viz., for the observation of the animal in his own habitat, unmolested by experimental conditions. The studies in this field of work cover such topics as the "expression of emotions" in animals (Darwin) and the general observations on instincts, such as migration, mating, homing, and fighting (Romanes, Morgan, Watson, and innumerable others). This method has its chief value for psychology in that it suggests many problems for accurate study, for unaided by experiment it can give us little concerning sense-organ activities or concerning the genesis of types of action. If a vulture approaches a heap of carrion, or if an owl catches a mouse, field observation can record the fact, but it cannot tell what sense-organs are involved. Did the vulture smell or

see his food? Did the owl see, hear, or smell the mouse? Only careful experiments upon the sensitivity of the animals concerned can give the answer. The same thing is true with respect to the nature and place of imitation and "reason" in animals. Field observations have constantly and insistently recorded phenomenal performances which are held to demonstrate the presence of these powers. Experimentation, however, has practically always either reversed the facts or shown the uselessness of such interpretations.

The method of general response applies typically to those cases in which the experimenter confronts an animal with a certain stimulus or object and notes its general, untutored, native response. Francis Galton was a prominent pioneer in the use of this method. Going through the zoölogical gardens of London, he sounded high-pitched notes on a whistle, which he carried concealed in his hand, near various species of animals. If the animal tested responded with any movements, Galton concluded that it could hear the tone in question. When carefully applied this method gives conclusive results on the question of mere sensitivity, but it is not so safe where discriminations between objects are involved. Unless, for example, the experimenter can secure one kind of response to sound and another kind to light, there is no way of telling whether or not these two forms of stimulation are different for the animal. Work on general responses has been done particularly in studies of hearing, smell, and taste in fish (Parker, Zenneck, Bernoulli).

The most important form of this method is that of *conditioned reflexes* perfected by Pawlow and von Bechterew. It has been used successfully in this country by Watson and his students, both on man and animals. The essential features of the procedure are as follows: Certain stimuli will without training arouse certain motor and glandular activities, e.g., taste will arouse a flow of saliva; increased light intensity will cause a contraction of the pupil of the eye; and pain will produce a

withdrawal of the part of the body injured. These activities are *unconditioned reflexes.* Certain other stimuli which do not naturally arouse the response will finally come to do so if they are associated frequently with the effective stimuli. Thus, saliva may flow from the sight of food or from the description of food, and we may jerk our hand back upon the appearance of an idea of a painful object. It will be seen that the method

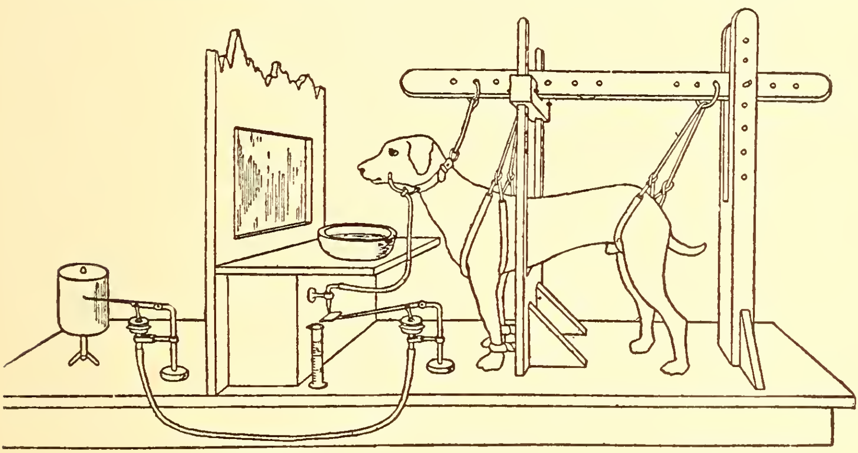

Fig. 1.—The Pawlow salivary reflex method (after Yerkes and Morgulis). Saliva flows from the dog's cheek through the tube, drops down upon a lever, and then flows into a graduated glass. This saliva, falling upon the lever, causes it to vibrate and accordingly to transmit the motion to the marker which records on the rotating drum. The flow of saliva in the graduate can be measured in quantity and then chemically analyzed.

takes account of the fact that one of the fundamental ways in which modes of action are varied is by changing, not the activity proper, but the stimuli which arouse it. Undue novelty has been attached to the method because most studies have been carried out upon the salivary reflex and upon simple protective reflexes, such as the withdrawal of the foot or the hand from pain, whereas all cases of habit-formation, learning, are equally true cases of the acquisition of conditioned reflexes. Figure 1 indicates the salivary method applied to dogs. By presenting

a sound, a light, a taste, etc., with food, it can be shown that if the animal is sensitive these objects will soon cause a flow of saliva if presented when food is absent.

The third method—selective response—is the most widely used behavior method among psychologists. It involves the same principle of association, or habit-formation, that we found in the conditioned-reflex method. In the present case, however, the animal is taught to associate certain objects—colors, sounds, etc.—with movements of its entire body. For example, it may learn to open a box or to run through a maze when placed near or in such an apparatus. In these instances the fundamental motives employed are hunger and the avoidance of pain. The animals are fed only after completing a test. They are never starved, but are fed just enough to keep them in splendid physical condition. Electric shocks usually serve for the punishments and are given when errors are made. The prime desideratum for this experimental work is that the response required of the animal (or man) shall not be opposed to its instinctive nature. The details of the method will appear in the presentation of results which we will soon give. It is interesting to note that often the results obtained by the conditioned-reflex method and the selective-response method do not agree. Thus Zeliony, using the former method, found sensitivity to tones in the dog, while Johnson, Hunter, and Barber, working with the latter method on dogs and rats, have found no evidence of sensitivity. The explanation of these divergent results is not yet forthcoming.

The experiments and results now to be described represent typical studies of various sensory and motor capacities of animals. They indicate how the problem of relative intelligence in man and animals must be solved. Other things being equal, that animal is most intelligent that can "sense" the most stimuli and can execute the most varied forms of muscular responses.

Tropisms.—We shall pursue our study of the capacities of animals according to phylogeny, beginning with the responses of animals of the simplest structure. Such responses are called *tropisms*. There are many definitions of this term, but to avoid the controversial aspects of the matter we shall define

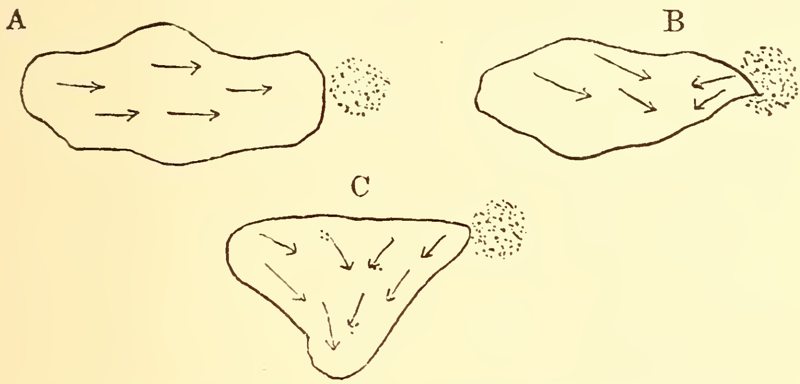

Fig. 2.—A negative tropism to a chemical in amoeba (after Washburn). The arrows indicate the direction of movement.

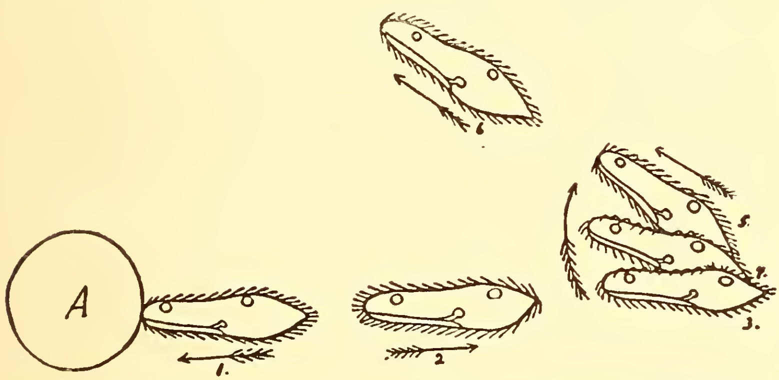

Fig. 3.—A negative tropism to contact in paramecium (from Washburn after Jennings).

tropisms as any inherited form of response in animals devoid of a nervous system. These responses are either positive or negative—positive if the animal approaches the stimulus, negative if the animal avoids it. The behavior can best be described with the aid of Figs. 2 and 3. Figure 2 represents an amoeba

coming in contact with a drop of chemical. The response or tropism consists in an extension of the protoplasm at some point of the animal's surface. Thus the amoeba gradually avoids or withdraws from the stimulus drop. If, in place of a chemical, light be used, the amoeba may either approach the light or avoid it, its response depending upon conditions that need not concern us here. Figure 3 represents a negative response of the paramecium to contact. Swimming in the direction of arrow No. 1, the organism encountered the new and harmful stimulus *A*. Thereupon the beat of the cilia (fine hairs on the surface of the body) was reversed in direction, and the paramecium backed away, turning at the same time away from the mouth-side of its body. The beat of the cilia was now again reversed, and the organism again swam forward. The same response would be made to any injurious object. Paramecium reacts to favorable objects by remaining in the favored locality. It accomplishes this by giving the negative response whenever its swimming activities threaten to take it beyond the optimal region.

In the simple behavior of these unicellular organisms we have the prototype of all higher forms of response. The amoeba, for example, shows sensitivity, motility, and conductivity (the transmission of energy in some form from the point of stimulation to the point of response). Subsequent evolution adds no new function but merely brings forth special structures to perform them—sense organs, muscles and glands, and nervous tissue. With this more complex development, organisms become sensitive to more varied stimuli, and they accordingly respond in more highly varied ways: i.e., they become more intelligent. The nervous system, whose function is the coördinating of sense-organ and motor and glandular activities, keeps pace with this development of sensitivity and motility. We shall trace its growth briefly in the chapter on "The Nervous System."

There is another way in which these simple organisms present facts of importance. They are sensitive (with almost no exception) to all the classes of stimuli that affect higher organisms. (Accordingly, we are able to call no one sense the most primitive.) Tropisms are classified according to the stimuli that arouse them as: chemotropisms, phototropisms, geotropisms (responses to gravity), stereótropisms (responses to contact), rheotropisms (responses to water currents), etc. These tropisms may be either positive or negative, depending upon the direction of the response. Two practical cases of importance are: the positive chemotropisms, which undoubtedly lead bacteria to attack certain tissue, and those that result in the sperm finding the ovum. Furthermore, when the carbon-dioxide content of the blood is high the stimulation of certain nerve cells by the changed chemical content of the blood results in increased heart-beat and in increased respiratory rate. This, too, although occurring in man, is undoubtedly a chemotropism. All tropisms are innate, inherited, and apparently they offer the only means of activity which these simple organisms possess, for there is no clear evidence that unicellular organisms learn by experience, i.e., form habits.

Instincts.—Our chief discussion of this topic will come in Part II. Here it is important to point out a few facts only. The term instinct refers to all forms of inherited response in animals having a nervous system. Inherited responses, since they form the behavior nucleus with which each organism starts its life, are the fundamental stuff upon which later experiences must build. In the case of the unicellular organisms, we have just learned that the inherited responses form the sum total of their behavior possibilities. In higher organisms the possibility of habit-formation is present in addition; yet these habits must be formed out of the materials offered through heredity by instincts and reflexes. Practically all of our knowledge concerning this original and fundamental side of animal and

human nature comes from the study of animals below man—a condition that is due to the greater convenience of animal material for study and, in many cases, to the greater definiteness with which the instincts manifest themselves there. Aside from field studies, mention may be made of Yerkes and Bloomfield's demonstration that kittens kill mice instinctively rather than as a result of imitation; of Breed's and Shepard and Breed's proof that the instinct of pecking in the chick is imperfect at first and later improves greatly with practice; and of Conradi's demonstration that sparrows have an instinct toward vocalization only, whereas the particular songs will depend upon the birds with whom they are raised. Detailed accounts of two of these studies will be given in chapter iii, Part II, where reflex action and instincts are more fully discussed. Studies on instincts and tropisms are made almost entirely by the naturalistic and general-response methods.

Sensory Processes.—So far in our account of animal psychology we have commented upon problems, methods, and inherited forms of response. We shall now present briefly certain typical studies upon sensory processes and then turn to an account of habit-formation and other "higher capacities." Let us first take up the sensory processes arising from the activity of muscles and inner organs, kinaesthetic and organic sensitivity. These processes are usually studied by the use of an apparatus termed the maze. Figure 4 shows the plan of a maze used in the study of small animals. The animal starts at the entrance and must run to the food-box, in the center where it secures food. On the first trial the animal probably requires 20–30 minutes, finally blundering into the food-box by accident. On subsequent trials the run is made in shorter and shorter time and with fewer and fewer errors, until the animal runs about 2–4 feet per second (if it is a rat) and makes no deviations from the true path. A typical learning curve is shown in Fig. 5, representing the gradual elimination of errors as learning

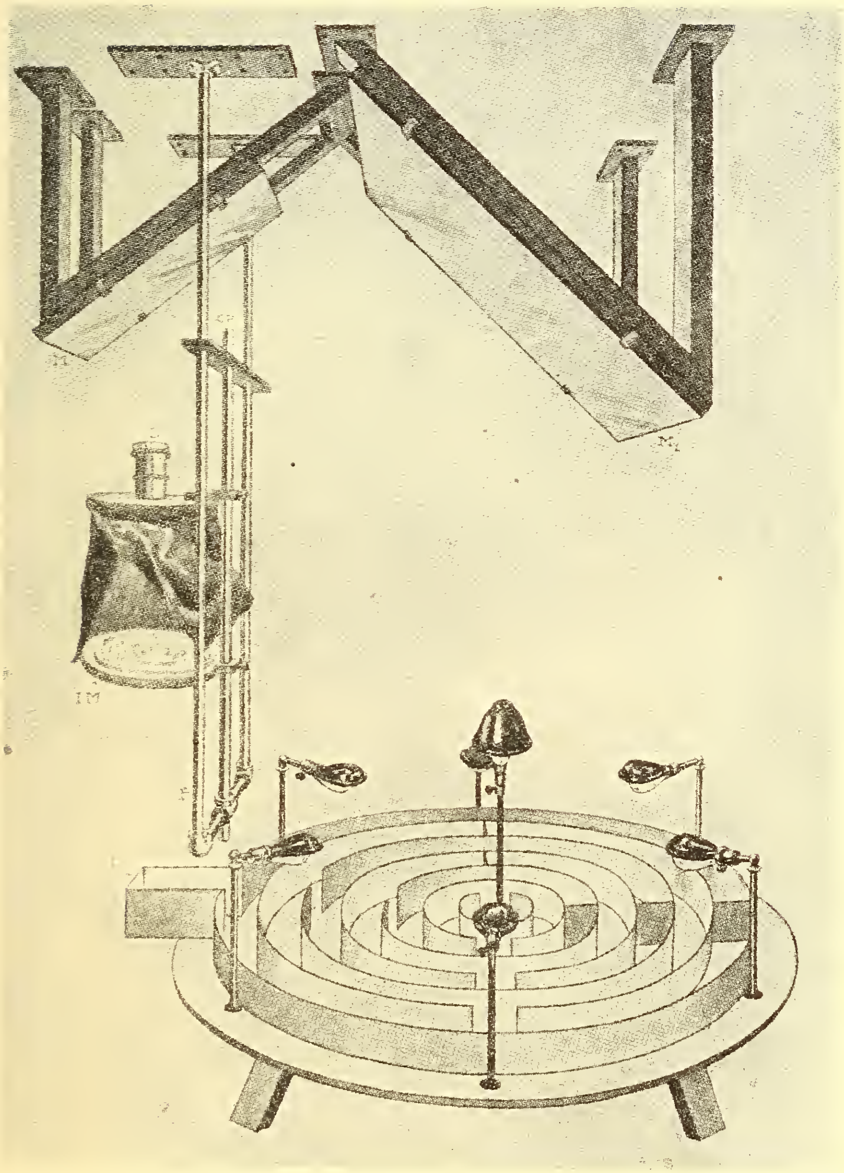

FIG. 4.—The circular maze and camera lucida attachment (from Watson). *SB*, entrance; MM_1, the mirrors; *L*, lens; *IM*, image of maze and animal that is in it. This apparatus makes possible the accurate recording of the distance traversed by an animal. This is done by tracing on *IM* the path followed there by the animal's image. Such a record is important in showing the gradual formation of the habit.

proceeds. Watson showed that white rats can learn this problem in terms of kinaesthetic (nervous impulses coming from the muscles, joints, and tendons) and organic sensory processes, sound, vision, and smell being unnecessary. After it has learned the problem the rat runs the maze as automatically and as surely as we go into our bedchamber in the dark, walk in a certain direction, reach up and touch the light. The response in both cases is guided by kinaesthetic sense-organs,

FIG. 5.—A learning curve for the Hampton Court maze, based upon 19 normal rats (after Watson).

and in our case we say "we just feel how far and in which direction to walk." If the maze is constructed so that it can be shortened by taking out a section without disturbing the interrelations of the turns, rats that have learned the problem previous to the change will now run into the ends of the alleys and run past the proper openings, just as we would fail to reach the light if someone had moved it. Experiment is constantly showing the predominant importance for all behavior of these kinaesthetic processes. Vincent has shown that rats can

utilize odor, contact, and vision in learning the maze if such differences are made sufficiently prominent. However, as the response becomes automatic it comes more and more under the control of the muscle sense, until finally the other sensory cues lose their function.

A very large number of experiments have been performed on vision in animals, particularly by Hess, Watson, Yerkes, Johnson, and Lashley. The tests have been on visual acuity, pattern perception, and the sensitivity to white and colored light. Especial interest attaches to the last problem. Do animals see color? More accurately stated the question is: Do they respond to monochromatic light? The earlier work used colored papers as sources of light. The animal was required to select a certain color located irregularly relative to the other colors, in this manner securing its food. Evidences of color vision were found, which were untrustworthy, however, because of the many uncontrolled sources of error. Even a color-blind individual might have succeeded in the tests, for such papers differ in brightness or intensity and in amount of color reflected (saturation) as well as in color proper. It is particularly difficult to interchange the intensity differences sufficiently to be sure that they and not the wave-length, i.e., the color, were the basis of the animal's response. Suppose, for example, that two colors, red and green, were shown to the animal, food always being given when the red was selected. If the animal finally succeeded in choosing the red 80 per cent of the time, it might be because the red was the darker of the two. And no change that could be made in the red papers might be sufficient to make the red the brighter, consequently causing the animal to fail in its response.

In order to secure color that would be strictly monochromatic and whose intensities would be thoroughly under control, Watson devised the apparatus shown in Fig. 6. This apparatus is entirely concealed from the animal tested, who sees only the

colors cast upon the plaster-of-Paris strips. These strips are at the end of a two-compartment discrimination box devised by Yerkes and shown in Fig. 7. The animal is introduced at *B* and must go through either alley *G* or *R* in order to return to *A* and secure food, which is given only as a reward for work

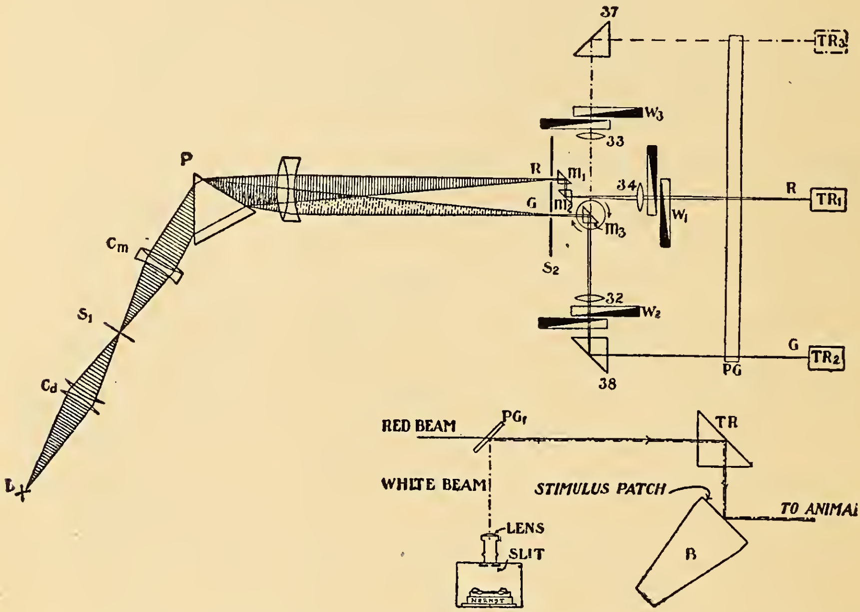

FIG. 6.—Ground plan of the Watson color apparatus. The pathway of the light is traced from the source at *L* through the lenses and prism to the strip S_2, where the particular color rays to be used are selected. These are permitted to pass and are finally brought to a focus on the plaster-of-Paris reflectors shown at *B* of the insert. The wedges W_1, W_2, W_3 serve to decrease the intensity of the light. The saturation or amount of color can be reduced by introducing white light, as shown in the insert.

done. If mistakes are made, slight electric shocks can be given through the wires in the alleys. Tests have been made with this apparatus on monkeys, chicks, rabbits, and rats. Although the actual results have varied somewhat from test to test, almost no evidence has been brought forward indicating that the animals concerned could form habits in response to stimuli

differing only in wave-length. Recently K. S. Lashley, however, has secured evidence of color sensitivity in chicks which leads him to believe that they react to color differences quite as readily as to intensity differences.

The difficulty of demonstrating color vision in animals may well lead us to inquire concerning the detailed procedure used in such experimentation. Three chief methods may be noted. (1) If the Purkinje phenomenon is present (see p. 261), color

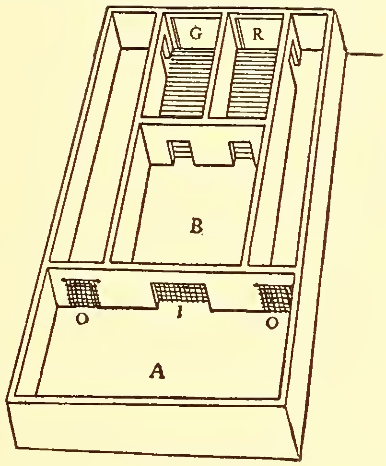

FIG. 7.—The Yerkes discrimination box described in the text. The plaster-of-Paris strips, circles, patterns, etc., that are to be seen and discriminated by the animal appear at *G* and *R*, presented in an irregular order to prevent the animal's use of position habits.

vision almost certainly exists. This phenomenon refers to the fact that in light of low intensity the brightest portion of the solar spectrum is the yellow-green; whereas in daylight illumination the yellow portion of the spectrum is brightest. This shift in brightness value does not occur in the color-blind person, who sees the spectrum as a series of shades of gray. (2) Trial may be made to force the animal to select a red as opposed to a given intensity of white light when the red is the darker of the two. When this habit is perfectly established, the brightness

of the red is increased or the brightness of the white decreased. If no intensity of white, from black to pure white, is confused with red, the animal undoubtedly is responding to wave-length or color. DeVoss and Ganson have presented evidence obtained by a method of this type, using colored papers, which has indicated color-blindness in cats. (3) In the third method two colors, e.g., red and green, may be presented to the animal as we have already described. If a discrimination is set up, the relative intensities or brightnesses can now be reversed. A persistence of successful choosing during this reversal would indicate color sensitivity. In making such a test our labor is much shortened and sometimes more fruitful if we know from prior tests how much it is necessary to change the relative intensities in order to reverse their values. There are many difficulties peculiar to the foregoing tests, but they must be passed over.

Studies on Habit-Formation.—We must turn now from cases of sensory discrimination to problems of habit-formation. Here we shall gain an insight into problems of behavior as presented by animals, which will continue to concern us, in man, throughout the book. In the first of our chapter we commented briefly upon the original modes of acting-instincts. Here, on the other hand, we are to consider certain phases of derived or habitual behavior. The studies on habit-formation are studies of learning and forgetting. It is very important to know what the laws of learning are and how conditions may best be adapted to secure the highest efficiency. Is it more economical to give one trial a day, or two, or three? Should one learn a task in parts or should one learn it as a whole, if economy of effort is to be secured? Does learning ability vary with sex and age? Do habits interfere with each other, and can efficiency in one task improve ability in another (transfer of training)? How does loss of retention proceed? Is it most rapid at first and slower toward the last? These and many

other problems of great practical value can be answered as well or better by tests upon animals than by tests upon humans, for with animals we more readily control motives, prepossessions, and modes of living, and we can also secure more convenient material.

In Fig. 8 are summarized the data obtained by Ulrich with white rats tested to determine which favored economical learning the most—1, 3, or 5 trials daily. The tests required the

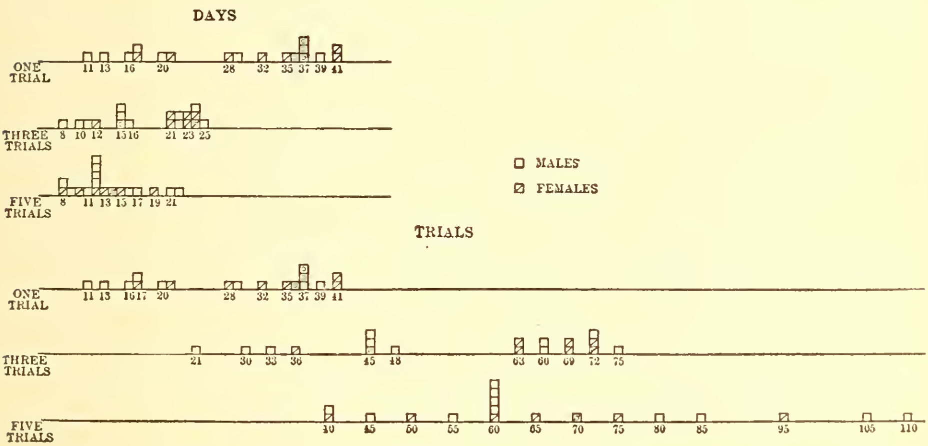

Fig. 8.—Results secured by Ulrich on the efficiency of distributed effort. The figure is further described in the text.

rat to lift a latch in order to enter a box and secure food. The rat was said to have learned the problem when it ran to the box and lifted the latch in a minimum time. From the curves, which record both the number of trials and the number of days required to perfect the habits under the several conditions, the general conclusion can be drawn that the less frequent the trials the fewer trials but the more days are required for learning. Which method is the more economical will depend upon the value one wishes more to conserve, time or trials.[1]

Evidence that certain habits may aid or hinder the formation of other habits (cases of the transfer of training and of

[1] For a further discussion of economical learning see chap. ix, p. 309.

habit-interference) has been reported particularly by Yerkes, Hunter, and Wylie. The second investigator mentioned has shown that the formation of a given habit interferes greatly with the formation of an opposite habit, while the formation of this second habit may not affect the retention of the former. Cases are also on record where transfer has occurred between visual and auditory habits, as opposed to transfer between two habits each aroused by vision or hearing. Other studies of habit-formation might be cited, but the foregoing will give a clear idea of the methods employed and the goals to be attained.

Imitation.—In the topic of "Imitation" and the following one of "Delayed Reaction" we shall describe briefly two important examples of "higher capacities" in animals as referred to above, page 14. We shall define imitation here in the simplest possible manner as the performance of an act by animal No. 1 by virtue of having perceived the same act performed by animal No. 2. We shall discuss imitation at greater length in the chapter on "Social and Racial Psychology," page 91. At the present point our intention is to illustrate the typical method of studying the problem experimentally whether in man or animals.

Haggerty has made the most thorough test of the presence and nature of imitation in animals, using monkeys as subjects. Studies on imitation have also been made by Hobhouse, Thorndike, Berry, and Watson. Haggerty's method was as follows: Monkey No. 1 was placed in a cage where he could secure food by climbing up the wire, jumping to a chute, reaching his hand up this, and pulling a string. If monkey No. 1 failed to learn the problem, he was taught it by the experimenter. Monkey No. 2 was now tested and, let us assume, failed. No. 2 is now confined in a small cage within the larger one and in such a position that he can see monkey No. 1 solve the problem and get the food. If after witnessing this performance a certain number of times No. 2 is given a chance and succeeds (even

after much effort), it is evident that No. 1's behavior has aided him. Does this result mean that imitation is present? No, not if by imitation it is meant that animal No. 1 concludes because No. 2 secured food in such and such a manner that therefore he, No. 1, can also. It does indicate that his attention has been vividly caught and held by seeing another member of his own species secure food, and that when he himself was given an opportunity he went to the place where food had appeared the time before. The influence excited by the first monkey upon the second one was a social influence, a specific incentive to increased activity. There is no clear evidence that animals imitate rationally in the sense that man sometimes does. However, the facts are not entirely clear with respect to what man does in cases of imitation.

The Delayed Reaction.—The instances of animal behavior so far described are all cases of responses to present stimuli. A color, a sound, or a series of pathways is presented to the animal, and he is forced to make a selection. Upon the basis of his ability to select we determine the stimuli to which he is sensitive. The delayed reaction is a study of responses made when the stimuli are absent at the moment of response. A cat, for example, sees a mouse appear at a hole. The mouse disappears, and sooner or later the cat reaches the hole. The delayed reaction introduces, in addition to this element of delay between the disappearance of the stimulus and the beginning of the response, the element of selection. Let us suppose that there are three holes and that the mouse had appeared in each one an equal number of times. After the mouse has appeared and disappeared at one hole, would the cat pick out which hole to go to? If it could for a short interval of time, how much would this need to be increased before the limit of the cat's ability would be reached? And then, most important of all, what method did the animal use in solving the problem? The delayed reaction has been studied with rats, dogs, cats, raccoons, and children.

In Fig. 9 is shown the apparatus used with cats. It is in principle the same as the apparatus used in the problem with other animals. The method of procedure is as follows: an animal is placed in *R*, the release box; a light can be turned on in either of three boxes; the animal's exit from the apparatus is blocked save through the lighted box. When the animal is

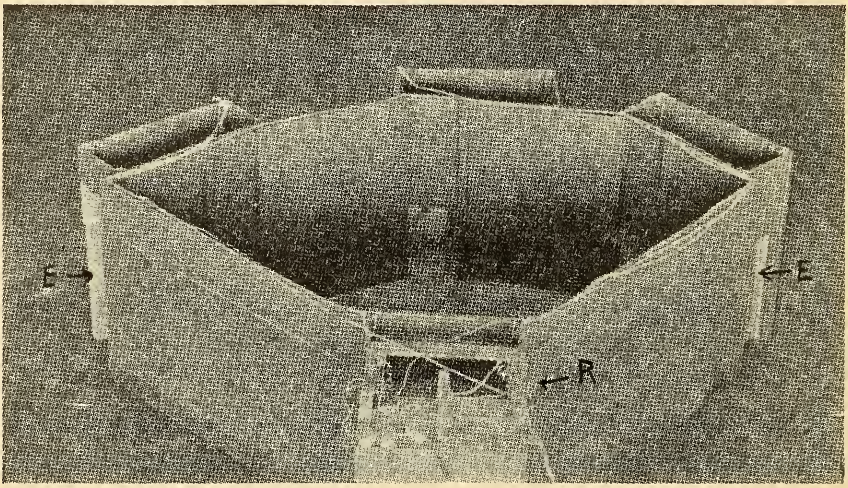

FIG. 9.—The delayed-reaction box (after Yarbrough). *R* is the release box in which the animal is detained during the interval of delay. An electric-light bulb is visible in the central box at the rear. The animal must escape from the apparatus through the exit *E* of one of these three boxes, each of which can be illuminated at will. The experimenter stands near *R*, separated from the apparatus by an opaque screen. This prevents the animal from catching cues or suggestions from him.

released it must learn always to go through the box which is lighted (or in which a noise is sounded, if sound is the stimulus) and return to *R*, where food is given. When once the animal has perfected this association of light and food, the real problem begins. The experimenter then places the animal in the release box; turns on the light in some one of the three boxes; when the animal has seen the light, turns it off; keeps the animal in the release box for a certain interval of time; and finally

releases it. Will it go out the box that was most recently lighted? If this is the case, the period of delay is increased, until the limit of the animal's ability is reached. The maximal intervals of successful delay obtained in this problem are as follows:

Rats	1 to 5 seconds
Dogs	1 to 3 minutes
Raccoons	10 to 25 seconds
Cats	16 to 18 seconds
Child $1\frac{1}{4}$ yrs	20 seconds
Child $2\frac{1}{2}$ yrs	50 seconds
Child 5 yrs	At least 20 minutes

More interesting than the length of time that an animal can successfully delay are the methods employed by it. (It must be remembered that there is nothing outside the animal's body to tell him which box to pass through.) The rats, cats, and dogs (Hunter and Yarbrough) had to keep their heads or bodies oriented toward the proper box if the correct reaction was to occur. Raccoons, dogs (according to Walton), and children, however, could lose their orientations during the delay and still react correctly. There was some process within their bodies which could be used to guide the proper response although the animals had not remained facing the proper box during the interval of delay. The hypothesis advanced in explanation is that this process or cue comes from the muscles of the animal and is kinaesthetic in kind. Its function is that of an *idea*, because it enables the animal to react to an absent object in a selective manner, although it—the cue—has not been continuously present.

Conclusion.—We have now canvassed typical problems and results from the field of animal psychology. We have seen enough of the methods to gain a fair insight into the methods of procedure and the safeguards that are employed. There are numerous problems, however, such as that of language

capacities, that we have been unable to describe for lack of space, although they are of great importance in a comprehensive survey of the field. Our introductory discussion of this field leads us to see the importance of careful, objective methods in a phase of psychology that is very concrete. It calls our attention to forms of behavior that are common to man and animals and also to forms that are strikingly different. The variations in the sensory and motor equipment of man and animals are the things that are termed variations in intelligence. An animal that can see more or hear more than another animal is to that extent the more intelligent of the two. So the animal that can adjust itself by muscular movements in the most varied ways is the most intelligent animal in that respect. This latter difference may occur between animals possessing the same sense-organs and the same muscles. The difference is one that is determined within their nervous systems, for some nervous systems are inherently less plastic and adjustable than others. In the following chapter on "Individual Psychology" we shall deal continually with questions concerning this general intelligence or adjustability in the human organism.

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CHAPTER II

INDIVIDUAL AND APPLIED PSYCHOLOGY

I. INDIVIDUAL PSYCHOLOGY

Introduction.—One of the most striking characteristics of human nature is the fact of individual variation. This variation occurs not only in the sort of material that goes to make up the consciousness of the person, but also very significantly in the ability to use this consciousness in solving the problem of adjustment to environmental demands. Individuals vary in temperament and mood, their emotional responses differing in the same situations. Their sense-organs vary in acuity, so that what one can see or hear may be quite beyond the range of another. In addition variation may be due to defects in the sense-organs. To illustrate, the person may be blind to all colors or only to certain ones; he may be deaf to certain tones; or he may be unable to feel contact over certain areas of his skin (and thus be anaesthetic). In a similar manner variations can be recounted in each of the specific types of conscious processes. Many of these will be discussed in Part II, where an analysis is made of normal adult consciousness. At that time a brief description will be given of one of the most noteworthy of individual differences in conscious content, viz., variations in image-type. It is sufficient to say here that in thinking of an object when the object itself is absent some individuals make use of visual images (mental pictures); others think in terms of how the object sounds (auditory imagery); others in terms of how it feels to contract the vocal muscles and speak the name of the object (vocal-motor imagery), etc. A very nice problem exists in the diagnosis of the type of imagery used by a given individual.

We have been giving samples of the problems of individual variation in conscious content. Of greater importance, however, at the present time are the problems arising from behavior. There are, of course, functions worthy of analysis related to each of the states of consciousness whose variations have just been mentioned. The most significant behavior problems in individual psychology, however, are those which deal with ability to solve typical difficulties in the environment. No one problem can be chosen in whose solution all persons will prove equally efficient, for they will distribute themselves through all the grades from very poor to excellent. The discovery and quantitative measurement of these variations in ability are of great practical importance in two fundamental directions. In the first place, it is important to know how an individual ranks with the other members of his group in *general ability*, i.e., in his native capacity to learn, in his ability to adjust himself to new situations. Those who occupy the lowest level of ability are known as the *feeble-minded*. *Genius* is at the other extreme, occupying the highest level of adaptive ability. In the second place, there are studies of *special ability*. These center attention primarily upon an individual's relative capacity in a particular situation, forming the basis of scientific vocational guidance, a field of study which is as yet in its infancy. It involves the perfection of tests for the selection of those best qualified for musicians, telegraphers, salesmen, officers in the army and navy, aviators, gunners, etc. Inasmuch as the various rankings of individuals are determined by the results of tests, individual psychology includes within itself the field popularly and technically known as that of "mental tests." In so far as the tests concern the variations of general ability with age, they include the most scientific and valuable portion of child and adolescent psychology.

The Binet-Simon Scale.—The best-known and most widely used scale of mental tests for general ability is the Binet-Simon

scale, first published in 1905. This was devised by the French psychologist Alfred Binet in 1904 in response to the request that he survey the schools of Paris for the purpose of detecting feeble-minded pupils. The scale as constructed was largely an elaboration and compilation of tests that Binet and his collaborator Th. Simon had already used for another purpose. The essential characteristics of the scale are as follows: (1) The establishment of the mental age of a child is sought in terms of the average performance of other children of that age. (2) A group of five tests is provided for each age, except at year 4. (3) The ages provided for range from one to fifteen. In addition five tests for adults are given. (4) All of the tests after the first two years require the understanding of language, and most of them require the subject to reply in terms of language. (5) Only one individual is examined at a time, the time required being from thirty minutes to an hour. A bare outline of the tests used from three years on is as follows:[1]

THREE YEARS

Shows nose, eyes, and mouth.
Repeats 2 digits.
Enumerates objects in a picture.
Gives family name.
Repeats a sentence of 6 syllables.

FOUR YEARS

Gives own sex.
Names key, knife, and penny.
Repeats 3 digits.
Compares 2 lines.

FIVE YEARS

Compares 2 weights.
Copies a square.

[1] A. Binet and Th. Simon. *A Method of Measuring the Development of the Intelligence of Young Children.* Trans. by Town (Chicago: 1913), pp. 7–9.

Repeats a sentence of 10 syllables.
Counts 4 pennies.
Plays game of patience with 2 pieces.

SIX YEARS

Distinguishes between morning and afternoon.
Defines in terms of use.
Copies a lozenge.
Counts 13 pennies.
Compares faces from the aesthetic point of view.

SEVEN YEARS

Right hand; left ear.
Describes a picture.
Executes 3 commissions.
Gives value of 9 sous, 3 of which are double.
Names 4 colors.

EIGHT YEARS

Compares 2 remembered objects.
Counts from 20 to 0.
Indicates omissions in pictures.
Gives day and date.
Repeats 5 digits.

NINE YEARS

Gives change from 20 sous.
Defines in terms superior to use.
Recognizes all the pieces of our money.
Enumerates the months.
Understands easy questions.

TEN YEARS

Arranges 5 weights.
Copies drawings from memory.
Criticizes absurd statements.
Understands difficult questions.
Uses 3 given words in 2 sentences.

TWELVE YEARS

Resists suggestion (length of lines).
Composes one sentence containing 3 given words.
Says more than 60 words in 3 minutes.
Defines abstract terms.
Discovers the sense of a sentence the words of which are mixed.

FIFTEEN YEARS

Repeats 7 digits.
Gives 3 rhymes.
Repeats a sentence of 26 syllables.
Interprets a picture.
Solves a problem from several facts.

ADULT

Solves the paper-cutting test.
Rearranges a triangle.
Gives differences in meaning of abstract terms.
Solves the question of the President.
Gives a résumé of the thought of Hervieu.

The calculation of the mental age of an individual on the basis of the tests outlined above is not a simple matter. The results secured are never so clear-cut as to make the determination automatic, for a child will pass all of the tests for a certain age and a scattered number of tests for higher ages. Accordingly, in giving him his final ranking, one proceeds as follows: the age at which the child passes all tests is termed his base age; then for every additional five tests belonging to higher ages he is credited with one year in addition to his base age. A child is diagnosed as retarded if his mental age is one or two years below his chronological age.

Criticisms of the Binet-Simon Scale.—The Binet scale established itself almost at once as the most reliable method of gauging general ability then in existence. Yet its use suggested many defects which led Binet himself to revise it. In this

country revisions have been proposed, particularly by Kuhlmann, Goddard, Terman, and Yerkes. Of these the latter two have made the most significant changes. In general we may list the chief criticisms of the scale as follows: (1) The tests for the early ages are too easy, and those for the upper ages are too difficult. Various other tests seem misplaced as to age. (2) The directions given for the application and grading of the tests are so general that confusion arises among different investigators. (3) The scale utilizes language ability to such an extent that it is inapplicable, particularly to speech defectives and to the deaf. Investigators have also found difficulty in adapting the scale to non-English-speaking subjects. (4) The method of determining mental age is inadequate. The Terman, or Stanford, revision attempts particularly to remedy the first and second criticisms. It also meets the fourth by following the German psychologist Stern's method of calculating mental age. In addition a more extended series of thoroughly tested and standardized tests for adults is offered. The Yerkes revision places chief emphasis upon criticisms 2 and 4. Criticism 3 cannot be met by a remodeling of the Binet scale, but a series of non-language tests must be devised and standardized. This task has been done most extensively by Pintner and Paterson (1917), and later by the army psychologists.

Performance Tests.—Let us first consider the scale of performance tests recommended by Pintner and Paterson, who were stimulated in their work by the necessity for testing deaf children. The scale includes fifteen tests derived from various sources. Three of these tests we shall describe briefly. (1) The Seguin-Goddard form board (Fig. 10) has been extensively used by Sylvester upon children of various ages. The problem for the child is the laying of each block in its proper place in a minimal time with no errors. The time limit allowed for solution is five minutes. (2) The pictorial-completion test devised by Healy (Fig. 11) requires the child to complete the picture

by the proper insertions of the cut-out portions. (3) The Knox cube test uses five small cubes. Four of these are placed in a row before the child and the fifth is held by the experimenter, who then calls the child's attention to his movements and taps the cubes with the one he holds. The number and the order of the taps may vary as follows: 1-2-3-4, 1-2-3-4-3, 1-3-2-4-3, etc. At the conclusion of one number the tapping cube is

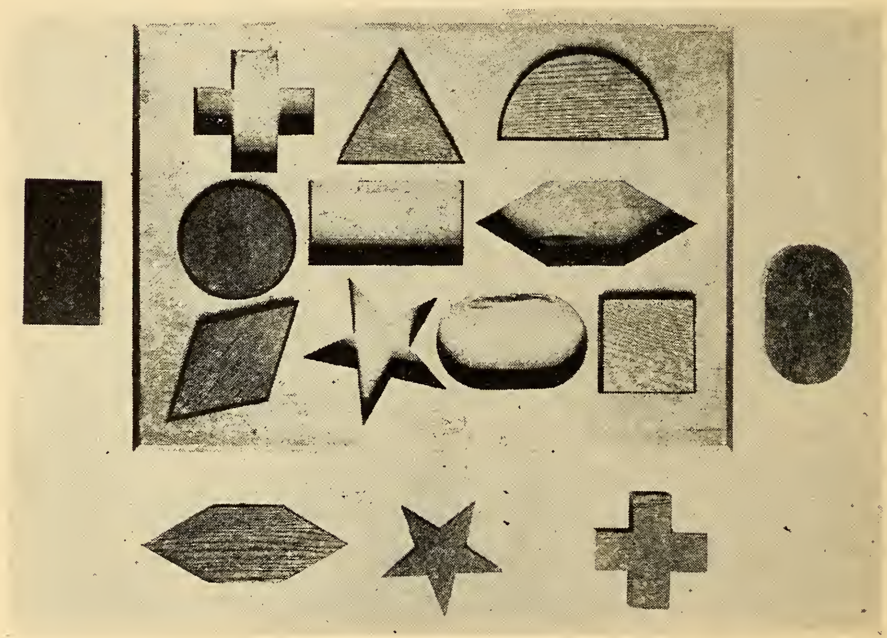

Fig. 10.—A typical form board

placed before the child, and he is told to tap likewise. A definite, invariable series of numbers is used with all subjects tested.

Pintner and Paterson, on the basis of extensive tests made by themselves and other research students, offer tables showing the grades made at various ages. It is found that both the time consumed and the errors made in the test decrease with the increasing age of the subject tested. In applying the scale to an individual child, the question of age credit comes up at

once. For example, what score must a child make on a given test in order to pass as a six-year-old in that test? Credit is not given unless the child's record is as good as the lowest of the upper 75 per cent of the children tested at that age. Seven-year

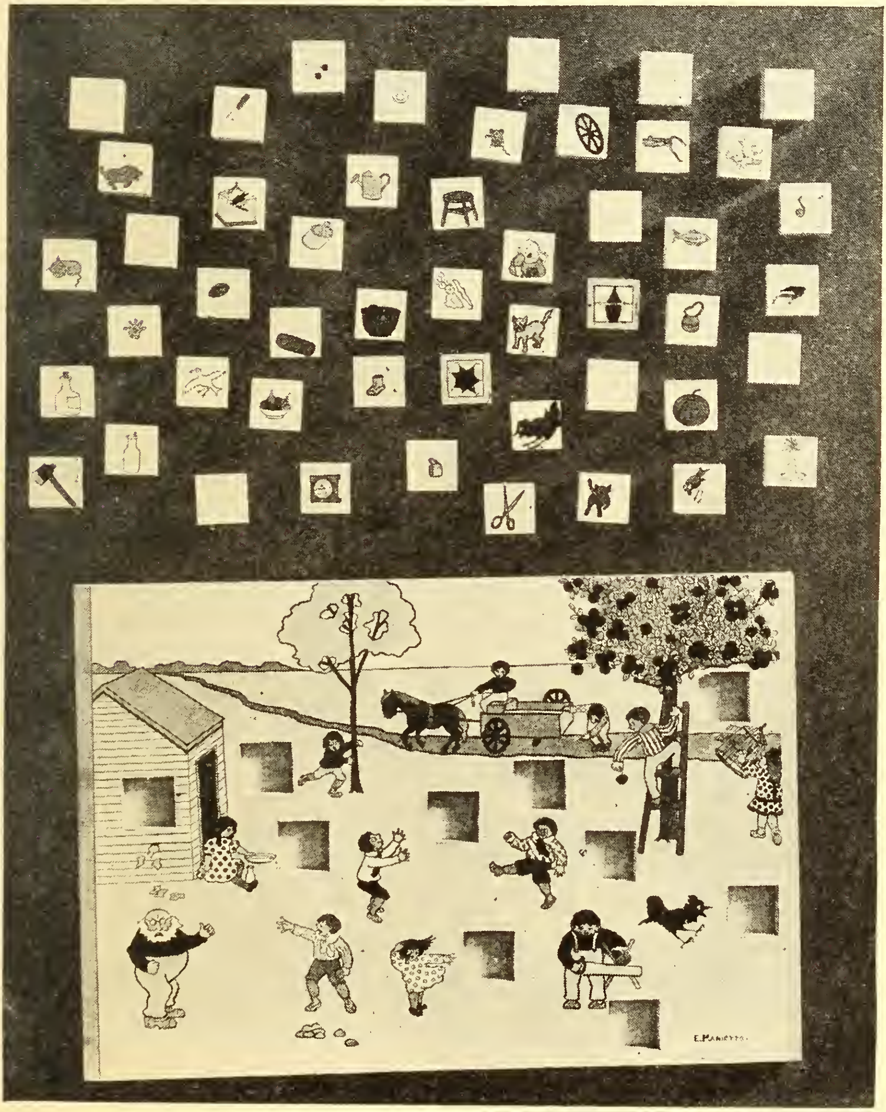

Fig. 11.—Healy's pictorial completion test

credit is given if the grade secured falls in a class with the upper 75 per cent of the children who are seven years old. In determining finally the mental age of a child the procedure may be the same as in the Binet scale: that is, a basal age is determined at which the child passes all tests; then additional credit is given for higher tests that may be passed. The mental age is the sum of the two.

The Calculation of Mental Age.—Terman and Yerkes have been the chief critics of the Binet-Simon method of determining mental age, which we have already presented in connection with the original scale and with the performance scale. Terman, following Stern, suggests the use of an *intelligence quotient.* It combines two points made by Binet into a single expression: that is, in place of stating a mental age (which Terman calculates on Binet's principle) and then stating its relation to the chronological age, Terman divides the former by the latter and terms the result the *intelligence quotient* or the *IQ*. This method recognizes the fact that a retardation of one, two, or three years in an eight-year-old child is more serious than the same retardation in a twelve-year-old one. A child of eight years and with a mental age of eight has an *IQ* of 100. If the mental age is 10, the *IQ* for the same child is 125. There is a probability that, barring accident and disease, the *IQ* remains the same for each individual throughout his lifetime. Terman's work was carried out upon 1,000 unselected children, and therefore well represents the frequencies with which the various *IQ's* occur in the general population from which they were taken. He found that only 1 per cent equal or exceed a score of 130; that 4 per cent come between 130 and 122; that one-third equal or exceed 106; that one-third equal or go below 95; and that 1 per cent equal or go below 70. As a result of his experiments Terman classifies the grades of intelligence as follows:[1]

[1] L. M. Terman. *The Measurement of Intelligence* (Boston: 1916), p. 79.

IQ	Classification
Above 140	"Near" genius or genius.
120–140	Very superior intelligence.
110–120	Superior intelligence.
90–110	Normal, or average, intelligence.
80– 90	Dulness, rarely classifiable as feeble-mindedness.
70– 80	Border-line deficiency, sometimes classifiable as dulness, often as feeble-mindedness.
Below 70	Definite feeble-mindedness.

In the following section the nature of feeble-mindedness will be discussed and illustrated. Here, in contrast, we shall cite one of Terman's cases of very superior intelligence. Notice should be given to the way in which the child's record bears out the *IQ*.

T. F. Boy, age 10–6: mental age 14; IQ 133. At 13–6 tested at "superior adult," and had vocabulary of 13,000 (also "superior adult"). Son of a college professor. Did not go to school till age of 9 years and was not taught to read till 8½. At this writing he is 15½ years old and is a senior in high school. He will complete the high-school course in three and one-half years with A to B marks, mostly A. Gets his hardest mathematics lessons in five to ten minutes. Science is his play. When he discovered Hodge's *Nature Study and Life* at age of 11 years, he literally slept with the book till he almost knew it by heart. Since age 12 he has given much time to magazines on mechanics and electricity. At 13 he installed a wireless apparatus without other aid than his electrical magazines. He has, for a boy of his age, a rather remarkable understanding of the principles underlying electrical applications. He is known by his playmates as "the boy with a hobby." Stamp collections, butterfly and moth collections (over 70 different varieties), seashore collections, and wireless apparatus all show that the appellation is fully merited. He chooses his hobbies and "rides" them entirely on his own initiative.[1]

[1] *Ibid.*, p. 99.

Yerkes, in his criticism of the Binet method of calculating mental age, suggests a point scale where the child's standing is given in terms of points and not in terms of years. A perfect score on the twenty tests (borrowed largely from those of Binet-Simon) of his scale is 100. One characteristic of merit in this new system is the fact that in many tests partial credit is given for partial performance in a way not possible with the Binet system of grading. Data have been gathered with the point scale showing approximate normal scores for children of various ages. By comparison with these standards (which are always open to further extension and revision), it is possible to determine the rank of a given child relative to the average or normal score for his age. The individual score divided by the normal for that age gives the coefficient of mental ability.

Group-Examination Methods.—The Binet-Simon scale and its modifications are essentially adapted to the testing of one individual at a time. Because of the length of time involved, they are not therefore suited to the examination of large groups of individuals, and yet this is practically necessary if one is to obtain a view of the intelligence of whole communities. Within recent years tests have been devised which can be given to groups of several hundred people at the same time. Each individual is supplied with an examination test blank and the group is given a definite time-interval of one minute, five minutes, etc., during which to work on each test. The score is indicated by the relative amount of work accurately completed in the time allowed. By this means one can rapidly survey a school system, a community, or an organization and secure its relative intelligence-rating. The practical importance of such data is tremendous in its possibilities. Why are certain city neighborhoods less progressive than others? Why are certain sections of the country poorly developed? The answer may well be found, not in the physical advantages or disadvantages of the land, but in the mental caliber of the population.

The Feeble-minded.—The scales for the measurement of an individual's relative mental ability are of fundamental psychological and sociological importance. We have just seen a suggestion of this in the account of group methods of examination. The group method is opening up a tremendous field where the chief interest is in the relative ability of all persons in the population. The individual method of Binet is chiefly interested in those of very inferior intelligence, the feeble-minded. The average and superior individuals may be held back by adverse social conditions, but they will never clog the machinery of progress with inefficiency, subnormal offspring, and crime. This is largely accomplished by the feeble-minded. As a result of the appreciation of this fact, the diagnosis of the mental status of the inmates of public institutions and of juvenile offenders is now an accepted and widespread procedure.

Estimates of the frequency of feeble-mindedness among delinquents range from 25 per cent to 50 per cent. One cannot return a simple answer to the query concerning the constitution of the criminal mind. It is certain, however, that a great portion of these individuals become criminals because of inability to understand and appreciate the customs and ideals of their group. Such an inability to understand is an intellectual deficiency. The frequency of feeble-mindedness is not so great among the general population. Terman found, as indicated above, 1 per cent feeble-minded in the 1,000 unselected school children studied. The percentage in the general population, however, is probably higher because the school systems include only the higher grades of the feeble-minded and the doubtful or borderline cases.

Three main grades of feeble-mindedness are recognized: the idiot, the imbecile, and the moron. The characteristic descriptions usually given of their industrial capacities after complete development has occurred are as follows:

MENTAL AGE	CAPACITY FOR ADJUSTMENT	GRADE OF DEFECT
Less than 1 yr.	Helpless	Low idiot
1 yr.	Feeds self, eats everything	Middle idiot
2 yrs.	Eats discriminatingly	High idiot
3 yrs.	No work, plays little	Low imbecile
4 yrs.	Tries to help	Middle imbecile
5 yrs.	Only the simplest tasks	Middle imbecile
6 yrs.	Tasks of short duration, washes dishes	Middle imbecile
7 yrs.	Little errands in the house	High imbecile
8 yrs.	Errands, light work, makes beds	Low moron
9 yrs.	Heavier work, scrubs, mends	Middle moron
10 yrs.	Good institution helpers; routine work	Middle moron
11 yrs.	Fairly complicated work with only occasional oversight	Middle moron
12 yrs.	Uses machinery; cares for animals; no supervision; cannot plan	High moron

These conditions just tabulated are generally regarded as incurable. Goddard has shown in the Training School at Vineland, N.J., that feeble-minded children who have reached their complete development fail to improve when tested with the same scale year after year. The accompanying figure (Fig. 12) shows three types of feeble-mindedness, all of which come from seriously defective ancestry. Although we cannot give a description of each case here, we shall comment briefly on that of Will T. His father was alcoholic and a sex offender. His mother, three of her brothers, two of her sisters, and her parents were feeble-minded. His two brothers and four half-brothers were also subnormal. These facts point to the most serious question in relation to feeble-mindedness, viz., the propagation

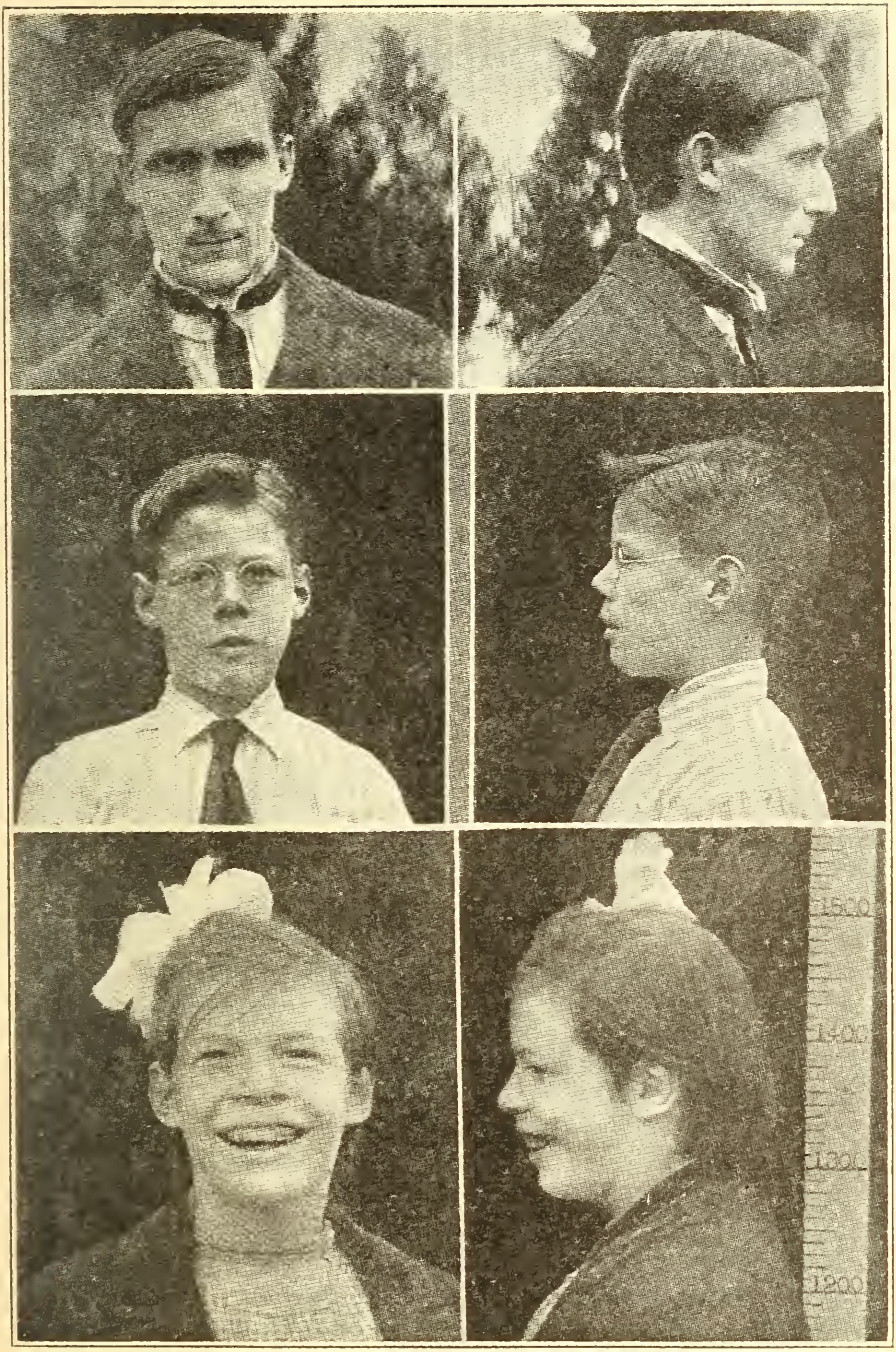

FIG. 12.—Three feeble-minded types (after Goddard)

Will T. (upper), age 21, mental age 8.
Isaac Q., age 16, mental age 10.
Prudence Q., age 17, mental age 3.

of defective children (always in large numbers) who become a social burden if not a social menace. The detection of these cases is one of the most important practical tasks of psychologists.

The Inheritance of General Intelligence.—The tale of the inheritance of a low grade of general intelligence is ominous, and is only offset by the reflection that normal and high-grade ability must follow the same hereditary law. The fact, furthermore, that feeble-mindedness is recessive (Goddard) makes it less frequent in appearance in the general population. Goddard has published the most extensive studies of the inheritance of mental defect. The most striking case, and therefore the one most widely known, is that of the Kallikak family. The story is as follows: During the American Revolution, Martin Kallikak, a young man of good family, became the father of an illegitimate son. The child's mother was a feeble-minded girl and the boy, Martin Jr., was like her. From this boy have come 480 descendants, practically all of whom have been feeble-minded and criminalistic. One of the last of these is Deborah, a moron, in the Vineland Training School. The story has another side, however. After the Revolution Martin married a normal girl, and from that union have come none but normal descendants, many of whom are of excellent ability. The two branches of the family live in the same section of the state, although they are in ignorance of their relationship. Indeed in one instance a member of the abnormal line is in the employ of a descendant in the other line. Nothing could show more clearly than these two lines of descent the terrible hereditary importance of mental defect.

The reader should study carefully the accompanying chart, on which are presented a few of the details of this family. Of the 480 descendants of Martin, 143 were conclusively proved to be feeble-minded, 36 were illegitimate, 41 were sexually immoral, 3 were criminals, 3 were epileptics, 24 were confirmed alcoholics, and 82 died in infancy. These individuals have in

general married, and their mates were usually others of similar ability; accordingly, Goddard finally had on his charts 1,146 individuals. Fig. 13 traces Deborah's ancestry in detail as far back as her grandparents. No greater argument for a prompt and serious consideration of eugenics could be offered than these records of the inheritance of low mentality with its resulting crime, poverty, and disease.

The Use of Statistical Methods.—The discussion must now turn from results back to methods. Individual psychology has made a more extensive and significant use of statistical method than any other field of the science. This condition has grown out of the dominating position occupied in the field by the mental tests which we have described above. These tests, as our exposition has already brought out, aim at placing a given individual in his relative place in

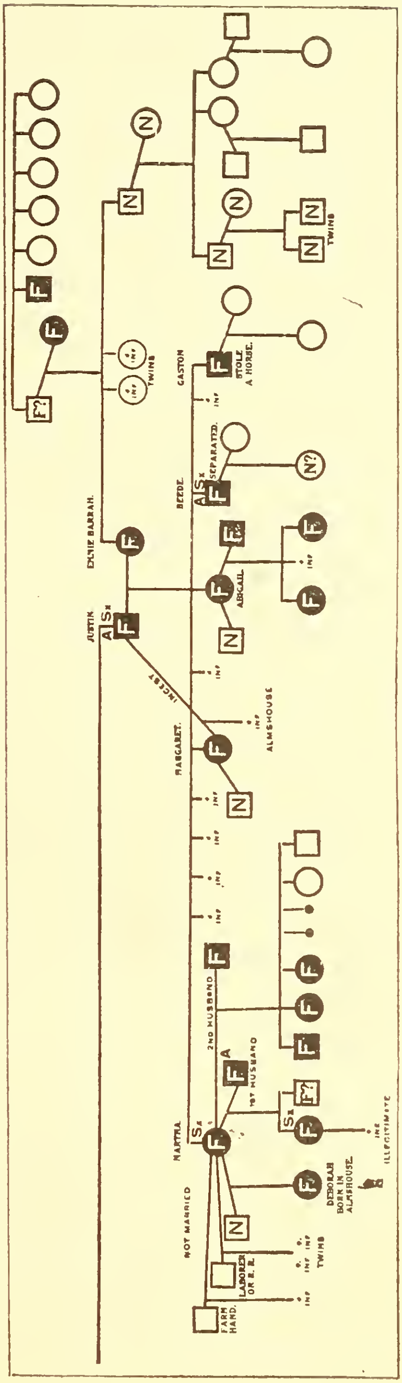

FIG. 13.—Deborah's ancestry as far back as her grandparents. The squares represent men; the circles, women. *F*, feeble-minded; *d. inf.*, died in infancy; *N*, normal; *Sx*, sex offender; *A*, alcoholic.

the population according to his ability in specific capacities and general adjustments. In order to do this it is necessary first to establish normal, or mean, records for the population concerned. The next step involves determining whether or not the norm is probably the true one for the group examined. There will be a certain amount of variation in the values secured for each mean when different classes of people or different conditions come into the experiment. It then becomes important to determine whether or not these differences are significant. Suppose, for example, that *A* has made a large series of tests on children five years old, and has found that the average, or mean, score is 10 points. He now tests another group of children of the same age and secures a mean of 12 points. Is this an accidental and insignificant difference in results, or does it indicate the presence of disturbing factors in the experiment? Mathematical formulas have been worked out by means of which this question can be settled. The same question must be asked when tests are made at different ages in pursuit of "age differences." Let us assume that there is a difference in the average scores for a group of children five years old and a group who are six. Is this a significant and therefore an "age" difference, or is it insignificant? Again, the above-mentioned formulas are used to measure the probable error of the difference of the two means. Unless the numerical difference exceeds the probable error at least four and a half times, the difference can hardly be held as significant. The illustration that we have used concerns the effect of age on the average score for a certain test. In like manner one must deal with the effects of any one of many other possible factors that may affect the results.

In addition to these data it is often very important to know how an individual's ranking in one test compares with his position in another. Is a tall person also in general a heavy one? Is one who ranks high in mathematics also of excellent ability

in science? To the extent that abilities, tendencies, or processes vary directly one with another, to that extent do we credit them with a causal relationship. This is *positive* correlation. *Negative* cases of correlation are those that vary inversely. Mathematical ability may always be great in those of poor literary ability, and vice versa. In this case one would speak of antagonistic causes at work. Instances of *indifferent* correlation are those where excellence in one field may or may not be accompanied by ability in another field. The relationship is one of chance. It is possible with problems of correlation to use mathematical formulas for determining the exact facts, and in many cases this determination is absolutely necessary if obscure relationships are to be detected. The method of correlation has the further value of aiding in the determination of exactly what is meant by such terms as general intelligence. Thus, if one test or scale, x, is known to correlate highly with intelligence, as the term is popularly understood, other tests or scales which correlate highly with x will also correlate highly with intelligence. And so one can gradually discover the ways in which intelligence acts. In standardizing tests, correlation is furthermore of particular value in checking up the test with the practical situation. Do the men who stand high or low in the tests also rank correspondingly in their duties as policemen, as salesmen, as students, etc.? The answer to this question is the final criterion of a test's (or of a scale of tests') specific validity.

II. APPLIED PSYCHOLOGY

It is difficult to draw distinctions between applied psychology and any of the other fields included in the present book. The term makes an unwarranted division between the psychology of an individual and the applications of this knowledge to some practical end. An adequate understanding of human nature involves the acceptance and use of both points of view.

When we approach the study of the abnormal, the social, the animal, etc., we apply all the psychology that is at our command in reaching an understanding of the problem. Likewise in the analysis of the normal adult individual—the task of "pure" psychology—one applies all of the information available in order to solve that question. Inasmuch, however, as the term "applied psychology" is in general use, we may employ it to cover certain comments upon psychology in medicine, law, education, and business.

Psychology in Its Relation to Medicine and Law.—Psychology and medicine come closest together in the topics we shall discuss in the following chapter on "Abnormal Psychology." The physician will be helped, to be sure, by a general understanding of the basic facts of human nature. His chief help, however, will come in the treatment of nervous and mental diseases from an understanding and appreciation of the following two points:

1. He should be familiar with the methods used by psychologists in testing the various sense-organs. This is no simple matter. It is a field for specialization in itself, for there are specific precautions to be taken in the study of color-blindness, in the diagnosis of defects in touch, etc. The chief interest in this topic finally centers upon the study of injuries to the nervous system with their accompanying mental defects. Medical men themselves have made the chief contributions to these investigations, but it is perhaps safe to say that it is only when the data and methods are put in relation to those of psychology as a whole that their full significance is caught.

2. The second chief value of psychology and medicine to each other lies in the analysis of the hidden forces of human character. Sigmund Freud has studied in great detail the bits of experience that become forgotten or voluntarily and even anxiously cast aside by each individual. These the average student has regarded as of no further influence upon conduct.

Freud, however, has claimed, and has presented much evidence to show, that these "repressed complexes" do persist in the unconscious. From time to time in certain individuals they reappear and distort consciousness, and in this way they produce the characteristic symptoms of many mental diseases. In a less serious form they crop out in the dreams, wit, lapses of speech, etc., of the "normal" individual. We shall discuss this fascinating topic briefly in the next chapter, and at that time the present comments should be recalled. It may well be insisted here, however, as it was above, that this field lacks breadth and sane perspective when it cuts free from the data on human nature presented in general psychology.

The contributions of psychology to law are much more one-sided. To understand law in its broad significance, one must appreciate the nature of society and of those forces which govern the interaction of men. Much of this material can be secured only in social psychology, which we are to review briefly in chapter iv. Mention may be made of two ways in which scientific data have been applied to the problems of the courts.

1. An effort has been made to secure criteria of valid testimony, and to measure the variations in testimony under different conditions. Subjects are shown pictures or events, e.g., for a brief interval of time and are then requested to give a report of what they have seen. Many mental processes are involved: concentrated attention, discrimination, power of interpretation, immediate memory, ability to adjust one's self quickly, etc. Even where the results do no more than confirm what one's experience would lead him to expect, they are illuminating in pointing out the complexity of the testimony situation. It is found particularly that children and abnormal adults do not testify accurately; that accuracy and quantity of testimony are to some extent in inverse ratio; that the form of the interrogation used in cross-examination has a great effect upon the evidence given; and that what a witness perceives depends

markedly upon his attitude and expectation. Further comments will be made in Part II, chapter i, in the account of attention.

2. At the present time the most valuable aid that psychology can offer law is in the diagnosis of the general intelligence of offenders. Although it is of supreme importance, we need not dwell upon this topic. The foregoing discussion of individual psychology has presented the methods of diagnosis used and the hereditary evils necessary to be combated. Various courts and institutions have already seen the necessity of arriving at an understanding of their wards before assessing punishment or planning reform.

The Relation of Psychology to Education.—The process of educating an individual is the process of adjusting him to his environmental problems. One may thus term the whole of the science of psychology "educational psychology." The careful student of education should be intimately familiar with the topic of instincts because they are the fundamentals upon which all modifications by experience must rest. He should be thoroughly acquainted furthermore with the psychology, or facts, of learning and memory in general. Finally, in particular there should be a sympathetic understanding of the field of general- and special-ability tests. Much of the valuable material in these topics owes its discovery to the urgency of pedagogical demand and to the enthusiasm of students of education. These problems are certain portions of the general field of human nature which, without the aid of men primarily interested in educational problems, would have been developed neither as rapidly nor as soon as they have been. *Educational psychology*, however, as a special field, deals with human nature so far as schoolroom conditions may make it peculiar or so far as unique adjustments may there be required of it. The principles of learning and habit-formation in general, e.g., are topics for inclusion in this field only so far as school children learn under

peculiar conditions. Typical important problems are these: What is the proper length of the recitation period? What learning processes are peculiarly involved in arithmetic, in spelling, in geography, etc.? How shall one grade or estimate ability in the various lines of training? What are the factors determining an individual's progress in the curriculum? To what extent are entrance examinations indicative of the future relative ranking of individuals? To what extent can one's ability in higher grades be predicted from his rank in lower grades? These and a host of other similar problems are being attacked and solved. The field of mental tests has an extension here in the scales devised for the grading of special school abilities such as arithmetic, writing, and language. Yeoman work has also been done in making intensive studies of the mechanics of reading and writing—two habits of fundamental importance in the educational scheme. Instruction and training in these professional problems are supplanting the earlier work, the attitude of which was that educational psychology consisted in general psychology plus a few more or less obvious applications to schoolroom conditions.

Psychology and Business.—The study and analysis of business problems from the psychological standpoint are increasing rapidly. The interest and the confidence of many large corporations assure the successful continuance of this work. Space limits our comments to a few illustrative cases only. Most firms that employ many men find at the close of a month, six months, or a year, numerous misfits who must either be dismissed or transferred to other branches of the business, where the trial continues. This constant "turnover" of employees means a great sacrifice for the firm in time, money, and efficiency. It is possible to devise tests to be applied to seekers of employment which will eliminate much of this waste. These tests are so arranged that they involve the habits and capacities required in a particular trade, such as telephone work, salesmanship,

expert gunner's work, etc. Each of these series of tests, in order to be rated as valid, must detect the salesmen, e.g., whom the firm has already found to be the most successful and also those who have proved to be the least so. No test or scale of tests can go back of this criterion of validity. The psychologist makes no effort to go behind the firm's own experience concerning the men who have proved most successful in their work; but he uses the rating of these men on his tests in improving and standardizing his scale. Such a general procedure is a vast improvement over the present methods, because it enables the employer to determine in a short time and at a minimum cost that which at present he can learn only after employing a man for a period of months or years.

As an example of the procedure we can give the test applied to telephone girls by Münsterberg. The problem was to devise tests that would detect those girls who held out promise of being successful in their work. Thirty women were used, among whom, unknown to Münsterberg, were some highly efficient operators placed there by the company. Sample tests used were as follows: (1) The auditory memory span was determined. This is the greatest number of digits that one can write down after having heard them slowly pronounced once. Numbers ranging from 4 digits to 12 digits were used. (2) Attention was measured by requiring the subjects to cancel out each *a* on a newspaper page. Six minutes were allowed and grades or scores were given on the basis of the amount and quality of work. (3) Space perception and the ability to make rapid accurate movements were tested. (4) Each girl was required to sort rapidly a complicated series of cards. The girls were ranked according to their ability in these and similar tests, and after three months these results were *correlated* with the experience of the telephone company. It was found that the subjects who ranked high in the actual telephone work also ranked high in the tests.

Business is interested not only in the employment of individuals capable as operators, clerks, salesmen, etc., but it is interested in sales brought about through the medium of advertising. An advertisement is a stimulus to response and is therefore subject to careful psychological analysis. Experimentation along this line has been well begun by such psychologists as Scott, Strong, Hollingworth, Adams, and others. Of the many problems available for study we may list the following: What is the effect on the selling power of the advertisement of the following factors: (*a*) the location on the page; (*b*) the frequency of its appearance; (*c*) the character of the type; (*d*) the character of the illustrations; (*e*) the colors employed; (*f*) the various types of descriptive reading, etc.? In performing these experiments suitable advertisements are used in such a manner that as nearly as possible only one factor shall be tested at a time. The "selling power" is measured under laboratory conditions in terms of what the subjects say concerning the appeal made by the various cases and in terms of what memory tests show of the different degrees to which the retention of the advertisement is affected by the factors concerned. Data so secured from a large number of observers can be of great economic value in business. To be of the greatest value, however, the results so secured should be checked up by actual selling returns for the different advertisements. In some cases this has been possible, and the outcome has held out encouragement for further study.

Conclusion.—The present chapter has been devoted to an exposition of certain practical fields of psychology. The subject is rapidly growing and is one that is expanding particularly under the stimulus of war conditions. In addition to the practical phases of individual and applied psychology, the chapter has given concrete data upon the variations of human nature as they concern the individual. The significance of such data was commented upon at the beginning of this chapter. Our

next study will be of the individual from the point of view of his abnormal behavior, the field where psychology and medicine come most closely together.

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CHAPTER III

ABNORMAL PSYCHOLOGY

Problems.—The field of abnormal psychology has long included a list of more or less unrelated problems, the claim for treatment of many of which lay in their unusual and mystic character. Here would belong particularly telepathy and spiritualism. Other problems, however, dealing with mental disease and the analysis of the less obvious forces of human nature rightly hold the positions of chief importance in the field. Here one finds a body of topics involving a growing accumulation of solid fact which is intimately bound up with individual and social welfare. The problems especially involved are those of multiple personality, hysteria, certain insanities, the inheritance of mental defects, dreams, and psychoanalysis. This is the series of topics which we shall examine briefly in our attempt to formulate a picture of human nature as it deviates markedly from the normal in the direction of disease. The present chapter, accordingly, is closely related to the preceding one, "Individual Psychology," which in so far as it dealt with feeble-mindedness dealt also with the subnormal. The dominant principle in the phenomena now to be studied is that of the disintegration, or splitting up, of consciousness into separate parts. On the physical side we are to assume the dissociation of the nervous processes underlying behavior. The most striking examples of this dissociation are the scientific cases which are very similar to the story of Dr. Jekyll and Mr. Hyde. Later in the discussion we shall have occasion to analyze these in detail.

The normal human individual is judged by his ability to adjust himself with average success to his own environment.

When we speak of mental diseases we refer to chronic cases of maladjustment to the environment. In many instances definite defects (lesions due to tumors, accidents, and disease) can be found in the nervous system which can be correlated with the mental disturbance according to the principle of cause and effect. These are the *structural psychoses. Functional psychoses, or neuroses,* do not reveal an accompanying nervous defect. There is every reason for assuming its presence, however, and for attributing our inability to detect it to our present inadequate methods of search. As examples of the structural neuroses we may think of cases of *general paresis,* whose cause is a syphilitic infection and subsequent destruction of brain tissue. This is the great outstanding structural neurosis, and we shall have occasion later in the chapter to describe both its mental and physical sides. Most of our study, however, will concern the functional neuroses. It is here that we come closest to the average daily experience of normal human beings. Here we find hysteria, paranoia, dementia precox, and other disturbances. Less abnormal are dreams, morbid fears, and the many cases of slips of speech and forgetting that insistently appear in daily life.

Defense Mechanisms.—The transition from the normal to the abnormal is very gradual and may well engage our attention through a discussion of defense mechanisms. It may well be stated as a universal principle that each individual is in constant conflict with other individuals and with various parts of his own individuality. He is a constant applicant for the approbation of others, for their respect, and for superiority over them. Furthermore he must retain respect for himself. His life must be valuable in his own eyes. Any experience with himself or others, or any memory of such experience, that tends to detract from the foregoing desires is unpleasant, tending to arouse fear, shame, remorse, regret, and other similar emotions. The unpleasant and the painful tend to be avoided by one means

or another. The simple organism may leave an environment that is too hot or cold and so defend itself from certain forms of pain and unpleasantness. Likewise, man may leave the society of other persons who refuse to look upon him with favor. In these social cases, however, where other selves are involved, not only is the individual haunted by the memory of past disapprovals, but he has also thrust himself into another social group where the same experience will probably be repeated. He cannot avoid his fellows entirely any more than he can fly from himself and his own unpleasant fears and reproaches.

In these cases where flight from conflict is useless or impossible, an individual constructs more or less consciously a system of defense mechanisms which serve to keep the unpleasant occurrences from invading consciousness. These defenses may take the form of elaborately thought out systems of ideas. One may find, e.g., a case where an individual, in order to avoid admitting his own incompetence, builds up the delusion of being persecuted by all whom he meets. He cannot hold his job. He goes from one field of employment to another, constantly driven—so he makes himself believe—not by his own shortcomings but by the envy and persecution of his associates. Systems of philosophy, while they are much more valuable socially than systems of delusions of the type just indicated, are also psychic shelters from the storms of conflict with an unfriendly world. The Stoics and Epicureans of the Greek and Roman age sought consolation and dignity in an ideal world when the real world seemed prone to fall to pieces about their ears. Similarly, the child who is shy and non-self-asserting may build up a mythical world of companions where he goes for play and comradeship. It is no rare thing for such a "defense" to last over into adult life. Furthermore, beautiful women and large robust men who may feel their mental shortcomings fall back upon poses and domineering attitudes as defense mechanisms for their self-esteem. Comfortable people who should

have economized as a patriotic duty during the Great War and who should have felt shame at being "unpatriotic" shielded themselves behind many excuses in order to gratify their desires. Thus the theater became necessary to maintain their spiritual morale; their automobiles must not depreciate from rust as gasoline mounted in price; and as for expensive dishes, "Why, one must not let the caterer starve, poor man!"

In the realm of disease, imagined pains appear which serve to ward off the undesirable. Backaches and headaches, pains in the eyes and elsewhere, keep the willing patient from his task. "The further advanced neurotic who already spends life in bed and thinks it monotonous to be alone, gets peculiar attacks in which, for example, he rushes to the window and tries to throw himself out; these attacks necessitate the continual presence of a nurse, in spite of the fact that the family can little afford the luxury. A poor woman who suffers from her insignificant position in life, often when she comes to any new place, has a habit of attempting suicide, so that everyone is frightened and she is thus made a topic of general conversation, as if she were some great celebrity—so for a time she is assured against the pangs of obscurity."[1]

As opposed to these more or less highly elaborated defense mechanisms is the simple one of forgetting. The thing which, if remembered, would cause unpleasantness or would arouse shame, remorse, lack of self-esteem, etc., drops from consciousness in accordance with an unconscious wish to be free from it. The recognition of this fact clears up many lapses of memory in daily life and many of the strange amnesias (instances of forgetting) of mental disease. Father constantly forgets to pay the bill for mother's hat. He may attempt to use his office key in the home door, having forgotten where he is in accordance with his subconscious wish to be back at the office. One may

[1] P. Bjerre. *History and Practise of Psychanalysis* (Boston: 1916), p. 141.

persistently insult an acquaintance by forgetting his name, thus indicating that he is of little importance. Likewise in the field of dreams the illustrations are legion. Painful incidents tend to be forgotten, and consciousness is thus saved an experience of shame, horror, and the like. In the field of mental disease the interpretation and the analysis of amnesias are particularly important. We shall discuss these cases under the topic of hysteria.

One further "normal" case may be cited by way of pointing out the mechanism of these instances of forgetting. In the lectures on a course in psychology, it was my custom to describe a certain experiment performed on the brain of a man while he was fully conscious. The surgeon's name was X. One session when the lecture was being given it was found that the name X was completely forgotten. In analyzing this unusual case of amnesia first one associated idea and then another occurred, until suddenly the name of Y appeared in consciousness. The explanation was then clear. Y was a close friend whose child had been suspected of being hydrocephalous. This was very distressing both to the parents and to the circle of friends. This unpleasant experience I had intentionally repressed and forgotten. Y took the child to X for diagnosis, and so X became associated in my mind with the unpleasant occurrence and was repressed and forgotten also. Even after this analysis I could not recall X's name. When it was looked up in a treatise on neurology, the name appeared totally strange and unfamiliar, so thoroughly had it been driven from consciousness.

The concept of defense mechanisms owes much to Adler, who has shown the intimate connection between "organ inferiority" and the mental life. The child or adult person who feels himself neglected, or ugly, or unloved, and consequently inferior, builds up a psychic compensation. He seeks refuge possibly by constructing an ideal world where he is not neglected or ugly, or he may remind himself of his own intellectual superiority

or the goodness of his deeds. Likewise, one whose vision is defective compensates for the fact by an acquired delicacy of touch or hearing. One who fears his lungs are weak may develop many mental peculiarities growing out of a solicitous attitude toward his respiratory apparatus, and he may, indeed, in combating his inferiority, develop a powerful physique. Defense mechanisms as described in this section afford the explanatory cue to many characteristics of the mental diseases to be described below.

Types of Mental Disease.—Just as it is impossible to separate sharply the normal from the diseased mental conditions, so it is impossible to draw any fixed lines between the different types within the field of mental disease itself. Descriptively the best one can do is to enumerate certain broad characteristics that appear to dominate in the more fundamental diseases. Therapeutically one must take each case on its own merits and deal with mental abnormalities in protean form. We may, however, follow Jelliffe and White (1915) in listing the chief mental diseases. Hysteria, compulsion neurosis, anxiety neurosis, and neurasthenia may be placed in a first group, termed by Freud the psychoneuroses and actual neuroses. Then may be listed a miscellaneous group: maniac-depressive psychoses; paranoia; epilepsy; dementia precox; psychoses due to infection, exhaustion, or poison; psychoses associated with such diseases as apoplexy, heart disease, chorea, etc.; and pre-senile, senile, and arterio-sclerotic psychoses. To these we shall add paresis. Jelliffe and White also add idiocy, imbecility, and feeble-mindedness, and we may recognize that these topics concern the field of mental disease as well as that of individual psychology. It is permissible, however, to separate the last three from the former list for the following reason: In idiocy, imbecility, and feeble-mindedness one deals with individuals who have failed to develop normal capacities of adjustment. In the other diseases or defects the individuals are suffering

from a loss of capacities that they once enjoyed. Obviously we shall be unable to deal even by definition with all the forms of mental disease listed above. Accordingly our purpose will be to sketch the bare outline of a few.

In the general class of mental disorders listed above, clinicians, as we have said, recognize a group of functional neuroses and one of structural neuroses. It is important that the continuity of nervous and mental diseases be appreciated. It is only in a transferred sense or by analogy that we speak of a "mental" disease, for the disease always rests upon the malfunctioning of nerve mechanisms. The two groups of defects may for practical purposes, however, be distinguished on the basis of apparent destruction of nerve tissue. Those mental diseases are "functional" in nature where present methods of search reveal no defects in nerve structure which might cause them.

Causes of Nervous and Mental Disease.—The causes of nervous and mental diseases are legion. Whatever interferes with the normal functioning of the nervous system produces nervous disease or defect and may also produce disturbances in consciousness. In such a list one may place: accidents, e.g., falls and wounds; hereditary or congenital defects; infectious diseases, e.g., scarlet fever, diphtheria, tuberculosis, and particularly syphilis; alcoholism; poisonings incident to certain occupations, e.g., lead and mercury poisonings; moral shocks, etc. Individuals vary greatly in their resistance to these disturbing factors. What will produce delirium, hallucinations, paranoia, or dementia in one person may leave another unaffected. The strain of nursing a parent during a fatal illness may produce hysteria in one person and only temporary exhaustion and distress in another. Syphilitic infection in one person may result in tabes, paresis, or other defect and in another may never manifest itself in the realm of nervous and mental disease. This lack of resistance may be termed an instability of nervous organization and is inherited.

The importance of heredity as a determining factor in any given case of disease can hardly be overestimated. We have had this brought to our attention already in the case of the Kallikak family which was presented in the foregoing chapter. This inheritance rests upon variations in the germ plasm of the individual, and is not a social inheritance in the sense that customs and traditions are. The social conditions surrounding

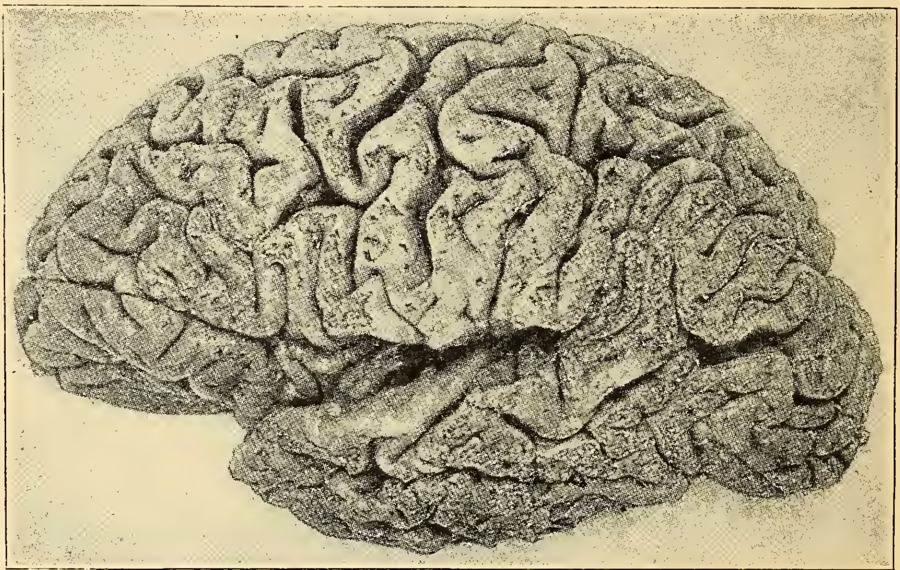

FIG. 14.—A lateral view of the brain in paresis (after Jelliffe and White)

the individual will determine largely the detailed content of his psychosis (abnormal mental state), i.e., they will determine the objects of his morbid fears; but they will not be the fundamental conditions of the disorder.

Paresis.—From the large field of mental disease we shall select four topics: paresis, paranoia, multiple personality, and hysteria. A brief presentation of these will give us much information concerning the abnormal phases of human nature. Let us first consider paresis.

Paresis, or *progressive general paralysis*, is a nervous and mental disease correlated with a certain type of cerebral syphilis. On the physical side there is not so much a paralysis as there is a general weakness. On the mental side progression is made in various typical ways to a final *dementia*, or loss of mentality. This gradual change may extend over a period of from one to five years. It is practically uniformly fatal. Apparent recoveries or remissions are usual, only however to be followed by a relapse and a fatal termination. Most frequently the disease appears in middle life, although juvenile paresis is also common. Figure 14 shows a lateral view of the brain with widespread destruction of its surface in paresis. This will be more apparent if the reader will compare the present figure with the one on page 150, which shows a different, but comparable, view of a normal brain.

Quotation may be made from Church and Peterson (1908) in description of the early symptoms:[1]

General paresis is one of the most insidious forms of insanity as regards its gradual, almost unnoticeable onset. Very often this early stage presents symptoms which lead to its being mistaken for neurasthenia. Indeed, the earliest symptoms may be neurasthenic in character, or even a combination of hysteria with neurasthenia. Sleeplessness, tremor, irritability of mood, hypochondriacal depression, dull headache, ophthalmic migraine, pains in various parts of the body, general malaise, loss of appetite, and digestive disorders—these are the manifestations which may be readily misinterpreted as purely of functional nature. It is only when other symptoms in addition to these are presented that a suspicion of a more serious malady may be entertained or the diagnosis actually established. These symptoms are, on the mental side: little faults of memory; errors in speech or writing; the misuse of words; the leaving out of letters, syllables, or words, or their reduplication in writing; growing indifference to the higher sentiments; loss of the critical faculty;

[1] A. Church and F. Peterson. *Nervous and Mental Diseases* (Philadelphia: 1908), p. 832.

small lapses in the proprieties, and failure of interest in the more important affairs of life. As these mental features become more and more pronounced, the patient loses and mislays things, makes mistakes in money matters, errs in appointments, confuses persons and objects, forgets his way, becomes easily angered, markedly offends the proprieties, shows extravagance in the use of money, evinces distinct loss of ethical feelings, exhibits proclivities to sexual and alcoholic excess, and becomes negligent of his dress.

After this initial, or *prodromal*, period the above symptoms increase in intensity. Amnesias (memory losses) become greater. Grandiose or depressed delusions become more striking; excesses more frequent and serious. On the bodily side many disturbances appear of which the following are typical: muscle tremors, particularly in the tongue and face; speech defects leading to a "drunken speech"; failure of the pupils of the eyes to contract to an increase in light intensity (Argyl-Robertson pupils); epileptiform or apoplectiform convulsions; and disorders of the hair, skin, and bone (trophic disorders). In the final stages the dementia becomes more and more profound, physical helplessness is usually complete, and death follows.

Paranoia.—Paranoia presents a very different picture from that just drawn for paresis, which is a structural disease. No changes can be found in the nervous system with which to correlate paranoia. It is therefore a functional disease. The heredity of paranoid patients shows marked neuropathic (abnormal nervous) tendencies. The disease itself may be characterized as one of chronic systematized delusions. Loss of mental power (dementia) is not usual until the later stages of the disease. It is very doubtful whether cures are possible and usually confinement in an institution is required, depending, however, upon the nature and intensity of the delusions. Many "cranks" and "peculiar" people that one constantly meets either are suffering from paranoia or are what may be termed

paranoid characters. People who have had a single fixed idea largely elaborated, who have regarded themselves as persecuted and as set apart from their fellows in ability and character, are paranoiacs. In this group can be found many leaders who have won distinction in war, politics, and religion. The treatment of the disease consists in change of scene, hard outdoor work, and general diversion.

Krafft-Ebing subdivides paranoia, as it appears after adolescence, into the following types on the basis of the nature of the delusions:

A. Paranoia persecutoria:
  a) the typical form,
  b) *paranoia erotica*, where the delusions are those of love and consist largely in the belief that others are in love with the patient and are persecuting him,
  c) *paranoia querulans* or the type that is always engaging in lawsuits and quarrels.

B. Paranoia expansiva:
  a) *paranoia inventoria* and *reformatoria*,
  b) *paranoia religiosa*,
  c) *paranoia erotica* in expansive form.

There seems to be good reason to believe that the systematized delusions of paranoia are defense mechanisms. Here, e.g., is a person who drifts from one job to another, failing at first from inability. Rather than admit his own inferiority, he begins to note seemingly suspicious behavior among his associates. They are spying upon him. They are carrying tales. They tamper with his work. Perhaps he reports the matter to his employer. Finally he is dismissed, and then he repeats the behavior in other situations. People soon begin to notice his peculiar actions, and their attention increases his persecutory delusions. Because his pains are many, he must have many enemies. Indeed, he is pursued by organized bands

and groups. He may now hit upon the suggestion that the persecution results from his own great superiority—his associates are jealous of his skill. He is a Messiah, or the world's greatest soldier, or inventor, or what not. His manly characteristics are such that he is passionately loved by a beautiful lady whom his enemies prevent from coming to him—endless indeed is the list of delusions the paranoiac may have. Auditory hallucinations are common. The patient's enemies talk about him maliciously even at night when he tries to sleep. He hears their voices although his persecutors remain unseen. The paranoiac may or may not react to his fancied persecutions in a way dangerous to himself or others, and a final stage of dementia may or may not close the chapter of his life.

Multiple Personality.—The study of multiple personality offers another example of functional psychoses. In a subsequent chapter we shall have occasion to discuss in some detail the nature of the self or personality of the normal individual. Here it is important to indicate certain more or less abnormal changes that may appear in this self. The average individual regards himself as a unitary being. He remembers the major portion of the things he encounters and of the actions that he performs. He has organized his behavior to such an extent that no feeling of strangeness attaches to the fact that his actions on the baseball field are governed by different standards from those which control his conduct in business or in the home. In a very true sense it can be said (as we shall see) that even though this individual's experiences are the possession of a single person, just as truly they may be regarded as belonging to three persons—a baseball self, a business self, and a home self. This view is justified by the fact of the three different standards of conduct that are used and by the fact of the very different interests of each self. It sometimes happens that the separation between the selves becomes so great that when one self is dominant no memory of the other selves exists; or, even

if the others are remembered, they are recognized as so different from the one dominant at the time that no question is raised in the mind of the individual whether or not there is really more than one self involved. Stevenson's story of Dr. Jekyll and Mr. Hyde is an instance well known to the laity. A few people are met in daily life who approximate this condition, and the annals of science contain many demonstrated cases.

Multiple personality, as we have said, *is a functional mental disease.* It is closely related to hysteria, and is regarded by the eminent French psychologist Pierre Janet as identical with that psychosis. Like paranoia these mental disorders are striking reminders of salient features in everyday normal life. An American psychologist, Dr. Morton Prince, has written (1905) a very fascinating account of a Miss Beauchamp,[1] who came under his care and who finally proved to be a composite of four different personalities. All four of these selves, of course, used the same body, but each must be regarded as employing a different organization of units within the brain. In the following quotations we shall present some of the chief characteristics of this most interesting case.

It was said in the beginning that, in addition to her normal self, and the hypnotic state known as B II, Miss Beauchamp may be any one of three different persons, who are known respectively as B I, B III, and B IV. . . . . The numbers were affixed to the personalities as they were chronologically discovered. That is to say, when Miss Beauchamp first came under observation she was known of course by her own name. Later, when she was hypnotized, her mental state in hypnosis was known as the hypnotic self. Everything was then simple enough, for we had to do only with a person awake and hypnotized, and no extended nomenclature was required. Later, when another mental state was discovered, it became necessary to have distinguishing terms; so Miss Beauchamp was called B I, the hypnotic state B II, and the third state (at first thought to be a

[1] Morton Prince. *The Dissociation of a Personality* (New York: 1905).

second hypnotic state, but later proved to be a personality) was named B III. Still later, a fourth state developed and was termed B IV.

B I was known as Miss Beauchamp.

B III was known as "Chris," in distinction from "Christine," the Christian name of Miss Beauchamp. Later, Chris took the name of Sally.

B IV had no other name, although Sally dubbed her "the Idiot."

Now these three personalities had very sharply defined traits which gave a very distinctive individuality to each. One might say that each represented certain characteristic elements of human nature, and that the three might serve as an allegorical picture of the tendencies of man. If this were not a serious psychological study, I might feel tempted to entitle this volume "The Saint, the Woman, and the Devil." The Saint, the typical saint of literature, is B I. Her character may fairly be said without exaggeration to personify those traits which expounders of various religions, whether Christian, Buddhist, Shinto, or Confucian, have held up as the ideals to be attained by human nature. To her mind selfishness, impatience, rudeness, uncharitableness, a failure to tell the truth or a suppression of half the truth were literally sins, and their manifestation wickedness, to be cast out by fasting, vigils, and prayer. She frequently makes allusion to such sins in her letters. B IV is the Woman, personifying the frailties of temper, self-concentration, ambition, and self-interest, which ordinarily are the dominating factors of the average human being. Her idea in life is to accomplish her own ends, regardless of the consequences to others, and of the means employed. Sally is the Devil, not an immoral devil, to be sure, but rather a mischievous imp, one of that kind which we might imagine would take pleasure in thwarting the aspirations of humanity. To her pranks were largely due the moral suffering which B I endured, the social difficulties which befell B IV, and the trials and tribulations which were the lot of both.

Not the least interesting of the curious nervous phenomena manifested, are the different degrees of health enjoyed by the different personalities. One would imagine that if ill health were always based on physical alterations, each personality must have the same ailments;

but such is not the case. The person known as B I has the poorest health; B IV is more robust, and is capable of mental and physical exertion without ill effects, which would be beyond the powers of B I; while B III is a stranger to an ache or pain. She does not know what illness means.

This personality, Sally, like the others at times is an alternating personality. But, besides this, at other times it is a group of dissociated conscious states, which, existing simultaneously with the primary self, whether B I or B IV, is technically termed a subconsciousness—a subconscious personality. This subconscious personality and the waking personality together represent a doubling of the mind. But this doubling exists because certain mental states have been dissociated from the main stream of consciousness and have acquired a more or less independent existence, and form an *extra* mind. As a result of long years of experience, the acquisition of long chains of memories, this second stream has acquired a wide field of mental life. Nothing of this life is known to the main stream of consciousness.[1]

These four selves had a curious relationship one to the other. B I knew only herself. B II knew herself and also B I, i.e., in reality knew the actual thoughts of B I without being told. B III knew herself and each of the first two. B IV knew only herself and was only known to B III through her actions. When we speak of B I's not knowing the other selves, we are pointing out remarkable instances of amnesia, or forgetting. All of these selves exist in the same body, but when B I, for example, is uppermost the other selves are forgotten and are absent. From the standpoint of consciousness they are non-existent. They persist only in a physical sense as changes of the brain. B III, however, knows what she herself thinks and can remember the thoughts and actions of B I. Without making quotations one can readily understand how at a loss and even how embarrassed B I might be by the situations into which B III might lead her.

[1] Morton Prince, *op. cit.*, pp. 15–18.

Particularly must this be the case since B III is the mischievous imp that she is.

We have not space to follow the history of this case through its many windings to the final discovery by Dr. Prince of who the *real* Miss Beauchamp was. We must be content with the final outcome. B II was the real girl, only asleep (hypnotized). B I and B IV were the disintegrations of B II. Sally (B III) was an alternating personality to the real Miss Beauchamp. With the latter's final constant existence Sally disappeared. A description of B II can be given best in the words of Dr. Prince:

> [B II] was a person so different from B I and B IV, so natural and self-contained, and so free from every sign of abnormality that there could be no doubt that I had again the Real Miss Beauchamp. There was none of the suffering, depression, and submissive idealism of B I; none of the ill-temper, stubbornness, and reticent antagonism of B IV. Nor was there any "rattling" of the mind, hallucinations, amnesia, bewilderment, or ignorance of events, as had been the case in the earlier experiments. She knew me and her surroundings and everything belonging to the lives of B I and B IV. She had the memories of both.[1]

Hysteria.—Since the extended case-history which we have just given is in reality one of hysteria, our present account may be brief. Janet and Freud are the chief authorities on this defect. The former has contributed particularly to the descriptive analysis, and the latter to the explanatory analysis of the problem. We shall first summarize the topic as Janet views it.

Hysteria is characterized by great suggestibility resulting in a tendency toward the breaking away from consciousness of systems of ideas and functions. We saw the dissociation on a grand scale in the case of Miss Beauchamp. It may, however, be of any magnitude. It may merely take the form of slight recurrent muscular twitchings (*tics*) either in isolated muscles or in the hands, shoulders, etc.; of somnambulisms; of hysteri-

[1] Morton Prince, *op. cit.*, pp. 519–20.

cal fits and seizures; or of long flights (*fugues*) that may suddenly take the patient from his work and result in his waking from the trance in some distant locality without knowledge of how he came there. Furthermore this dissociation may be either positive or negative in its expression. Novel movements, as just described, may occur, or the effect may be a *paralysis*. Likewise in the realm of sensation the hysterical person may not only hear, see, or feel strange things, i.e., have hallucinations, but he may fail to receive sensations when he is touched (anaesthesia), or when objects are presented to his other sense-organs. These paralyses and anaesthesias are the result of suggestion and may appear suddenly. They do not depend upon an injury to the body. They have been described as the expression or effect of subconscious ideas; but this explanation is unnecessary, for we need only assume that certain brain processes become separated from other neural processes and continue to function as though normal. A patient, for example, may encounter the suggestion that she cannot move her leg or that her foot is insensitive, and immediately the idea becomes a reality, i.e., she becomes either paralyzed or anaesthetic. In the Middle Ages anaesthetic areas of this type were well known and were regarded as indications that the person was a witch or possessed of devils. As we know, a conventional method of "witch discovery" was to explore the subject's skin with a needle for insensitive spots.

In concluding the descriptive illustrations of the splitting off of ideas or systems of ideas, let us give a case in Janet's own words:

We come back to the common story of a young girl twenty years old, called Irène, whom despair, caused by her mother's death, has made ill. We must remember that this woman's death has been very moving and dramatic. The poor woman, who had reached the last stage of consumption, lived alone with her daughter in a poor garret. Death came slowly, with suffocation, blood-vomiting, and

all its frightful procession of symptoms. The girl struggled hopelessly against the impossible. She watched her mother during sixty nights, working at her sewing-machine to earn a few pennies necessary to sustain their lives. After the mother's death she tried to revive the corpse, to call the breath back again; then, as she put the limbs upright, the body fell to the floor, and it took infinite exertion to lift it again into the bed. You may picture to yourself all that frightful scene. Some time after the funeral, curious and impressive symptoms began. It was one of the most splendid cases of somnambulism I ever saw.

The crises last for hours, and they show a splendid dramatic performance, for no actress could rehearse those lugubrious scenes with such perfection. The young girl has the singular habit of acting again all the events that took place at her mother's death, without forgetting the least detail. Sometimes she only speaks, relating all that happened with great volubility, putting questions and answers in turn, or asking questions only, and seeming to listen for the answer; sometimes she only sees the sight, looking with frightened face and staring on the various scenes, and acting according to what she sees. At other times, she combines all hallucinations, words, and acts, and seems to play a very singular drama. When, in her drama, death has taken place, she carries on the same idea, and makes everything ready for her own suicide. She discusses it aloud, seems to speak with her mother, to receive advice from her; she fancies she will try to be run over by a locomotive. That detail is also a recollection of a real event of her life. She fancies she is on the way, and stretches herself out on the floor of the room, waiting for death, with mingled dread and impatience. She poses, and wears on her face expressions really worthy of admiration, which remain fixed during several minutes. The train arrives before her staring eyes, she utters a terrible shriek, and falls back motionless, as if she were dead. She soon gets up and begins acting over again one of the preceding scenes. In fact, one of the characteristics of these somnambulisms is that they repeat themselves indefinitely. Not only the different attacks are always exactly alike, repeating the same movements, expressions, and words, but in the course of the same attack, when it has lasted a certain time, the same scene may be repeated again exactly in the

same way five or ten times. At last, the agitation seems to wear out, the dream grows less clear, and, gradually or suddenly, according to the cases, the patient comes back to her normal consciousness, takes up her ordinary business, quite undisturbed by what has happened.[1]

When this return of the normal state has occurred there is a complete amnesia for what has taken place during the seizure. Here we see again the same characteristics of divided personality that impressed us in the case of Miss Beauchamp.

Freud's conception of hysteria (dating from the initial study with Breuer in 1895), as we have said, is an explanatory one. The main question is, "Why should the amnesias exist?" for amnesias are the dividing lines for whatever dissociations there are within the individual. Freud answers this question with the concept of defense mechanism whose nature we have already sketched. Each individual is the scene for conflicts between fundamental tendencies. In order to unify itself and protect itself from unpleasantness, each system of ideas forgets or represses those that conflict with it. Thus in the hysterical case we have just described the young girl "forgot" her experience in nursing her mother as a defense against unpleasantness. From time to time, however, this repressed material would be re-aroused and would undergo what Freud terms *conversion* into the physical symptoms of the hysterical seizure. Freud would further insist that if the *psychoanalytic method*, soon to be described, were applied to each case of hysteria, the results would indicate two additional characteristics: first, the presence of infantile material (reminiscences from the patient's childhood); and, second, a close relation to experiences belonging to the sex life of the patient.

Freud's Conception of the Neuroses.—With the conclusion of our sketch of multiple personality and hysteria we are brought back to the topic of defense mechanisms with which

[1] P. Janet. *The Major Symptoms of Hysteria* (New York: 1907), pp. 29–31.

the present chapter opened. The last section has familiarized us already to a certain extent with Freud's views on mental disorder. We may now list the factors upon which he places emphasis in the explanation of mental defects and abnormalities as follows: (1) the repression (the driving from consciousness and therefore the forgetting) of any material that would lead to unpleasantness as a result of conflict with accepted standards of conduct; (2) the activity of accepted standards in the rôle of a censor; (3) the dominant place of sexuality, interpreted in its broadest significance, in the experiences producing conflict; and (4) the endeavor of the suppressed complexes or tendencies, disguised through symbols and condensation (abbreviation), to rise into consciousness by eluding the censor.

The Psychoanalytic Method.—The analysis striven for by the psychoanalytic method is a dissection of the repressed complexes which are characteristic of all people and which are abnormally developed in the mentally diseased (psychotic individuals). We may think of an individual's character after the analogy of an iceberg where the part out of water corresponds to that part of character of which the possessor is directly and immediately aware. The large portion beneath water-level will then correspond to the hidden and repressed elements in character. We are using the term character to denote the sum total of those forces that shape and determine conduct, and everyone will recognize that the great majority of these factors lie beyond immediate awareness. There is good reason for believing that nothing that is learned is ever completely forgotten. Furthermore no instinctive tendency is ever lost. The unpleasantness that may attach to much that is learned or to much that is instinctive will bring about its repression below the level of consciousness; but from this region of merely physiological processes in the nervous system the material will contrive to determine conduct and in that manner shape character.

Only a very special method can restore to consciousness experiences that were forgotten perhaps in infancy or early childhood and that have always been severely censured. Such a method, however, has been found in free association as adapted to psychoanalysis. Any experiences that occur together become associated in such a way that when one re-enters consciousness the other tends to follow. Thus if one has the idea "cat," the idea "dog" will probably follow by virtue of past associations. With this fact as the basis of procedure, the free-association method requires the individual to report to the examiner every idea that enters consciousness. To eliminate distraction as much as possible the patient is placed in a comfortable (reclining) position and is instructed to take a passive, non-resisting attitude, permitting ideas to come as they will. Many associations will be painful and will appear only after a struggle with the censor (the patient's standards). Accordingly, the patient must be told explicitly that all ideas must be communicated to the examiner without reserve, else the search through the hidden elements of character cannot proceed. It can be readily seen that in the hands of a skilful examiner this method is certain to bring to consciousness practically all of an individual's past experience, however indirect an association path must be followed. The great therapeutic value of psychoanalysis lies in the fact that when the origin and nature of a patient's morbid fears and worries are found and explained to him the symptoms gradually abate and may finally disappear; indeed, the cure of this type of abnormal, psychotic individual is largely a matter of re-education through a familiarity with his own personality.

The psychoanalytic method is an outcome of the method of hypnotism as used by Wetterstrand, Charcot, and others in the last half of the nineteenth century. Hypnotism is a method of producing artificial cases of multiple personality through suggestion. The essential procedure is to so concentrate the

individual's attention upon a monotonous and unchanging stimulus that the individual's censor is gradually "put to sleep." As a result the person in the state of hypnosis accepts as true the ideas suggested by the experimenter. Objects may be seen where no objects are, and vice versa. Actions may be performed that ordinarily would be regarded as foolish by the subject. Things may be said that are utterly unlike his usual speech. After the hypnosis has been removed a total amnesia exists for the period of its extent similar to the condition we saw in multiple personality and hysteria. It has been found that commands given the subject during the hypnosis with instruction to carry them out after the normal waking consciousness has been reinstated (post-hypnotic suggestion) will be duly obeyed at the appointed time. In this manner the experimenter may suggest that the subject will no longer suffer from certain pains, or morbid fears, or evil habits, and frequently results of much value have been obtained. At times apprehension has existed lest hypnotism be used to further criminal designs. Unless, however, the person hypnotized is already suffering from a poor voluntary control and initiative (*aboulia*), there is little danger, for a vigorous censor can, and will, check conduct that tends to depart in a serious manner from the normal.

In concluding the discussion of abnormal psychology (and it must be conceded that we have omitted many important topics, particularly dreams and dementia precox), we should repeat the statement that was made at the beginning of the book: no one field can be studied apart from the subject-matter of other fields. The picture that we have drawn of the abnormal individual is intimately linked with the picture that we shall have at the close of the book. Human nature is so complex that in order to understand and appreciate it the student must approach it from many sides. In the following chapter on "Social and Racial Psychology" we shall

make a further intensive study of human nature, this time with particular reference to the influence of race and society upon the individual.

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CHAPTER IV

SOCIAL AND RACIAL PSYCHOLOGY

I. SOCIAL PSYCHOLOGY

General Problems and Points of View.—Men and most animals show marked differences of behavior when in the presence of other organisms, notably members of the same species. This is the fundamental fact of social psychology—interstimulation and response. A strange ant entering an ant neighborhood calls forth characteristic behavior in the environment. A monkey, confined in a cage alone, becomes a different animal upon the introduction of a companion. In man we find such responses as shyness, coyness, and either a comfortable relaxation or a strained effort to make an appearance. These are all instances of social behavior. Social psychology seeks to describe and explain all such cases. It studies customs, traditions, fads, fashions, conventions, the crowd, the public, and the mob. Furthermore it analyzes law, religion, morals, language, and art, in order to indicate and appraise the psychological groundwork of these institutions. The prime prerequisite for carrying forward these investigations is an understanding of the nature of certain traits of the individual. Thus the social psychologist must understand original human and animal nature—the instincts and emotions—and must know how and to what extent it is possible to modify this original nature through the individual's experience. He must be familiar with the nature and workings of suggestion, imitation, and sympathy; and he must appreciate the activities of imagination and thought. Out of this social study of the individual grows a conception of the self as it is determined by a social environment—a condition of living from which none can escape.

So far we have stated the problems of social psychology in objective, behavioristic terms with no reference to consciousness. Very little attempt is made to approach these problems from an analytical, structural point of view. The descriptions of experiences that are given, however, often recognize very explicitly consciousness and its right to a place in the field of psychology. Studies of conscience, of conversion, and religious experiences in general, descriptions of mobs and analyses of the social self, are cases where consciousness occupies a prominent place.

The Nature of Society.—Ellwood has emphasized the view that by the term *society* is meant any psychic, or mental, interaction of individuals. Mere physical proximity and interaction are not sufficient to constitute social behavior. Paramecia may congregate in a drop of chemical, but they are not thereby a society; nor does the fact that human beings are herded together in a city make of them a society. Whether the marvelously complex activities of the ants and bees are social will depend, according to Ellwood, upon whether or not the interactions are conscious. This is a very important point of view and one into all of whose implications we cannot go. It is the distinction between consciousness and behavior meeting us again at a new angle. Current psychology includes both. The error comes, apparently, from the effort made to delimit sharply the social from the non-social. Inasmuch, however, as we have no certain method of detecting the presence and absence of consciousness in animals below man, we shall view as social behavior all cases where the conduct and behavior of an organism is modified as the direct result of the action of another organism. The responses of one individual are themselves the stimuli for the responses of another individual. Accordingly, we may say that all animals enter into social relations. The most primitive cases are possibly the food and sex reactions of protozoa. In the account that is to follow, however, we shall

confine our attention to certain selected topics from human social behavior. We shall, in fact, be led to see that practically all human responses are social.

The Origin of Society.—It was held by Hobbes and Rousseau that society is an artifact arising from a mutual contract between individuals when this finally becomes necessary for protection against mutual depredations. Such a view presupposes that there was a time when society, or social relations, did not exist and that social relations are to be limited to the fact of organized society and its phenomena. The present view would list as social even the "anti-social" facts of conflict.

Society is as old as man himself. (We are now ignoring the animals below man.) It is implicit in mating, and is prominent when the family—or a permanent union of the sexes with the consequent care of children—arises. Whether primitive or advanced, society's phenomena revolve about the fundamental instincts of food and sex. Suggestion has already been made concerning the rôle of sex. It is necessary to point out further that the term sex must be interpreted in the broadest way, covering courtship, mating, family life, and the rearing and education of offspring. Even the most casual inspection will show to what an enormous extent social phenomena are concerned with these activities. The place of the food-getting impulse is equally prominent. In primitive times individuals and tribes migrated from localities where food was scarce and sought more fruitful areas. Permanent villages grew up in these places and in locations possessed of trade advantages. Farming, dairying, horticulture, and animal-breeding—all are occupations arising for the production of food. Distribution, requiring the necessary means of transportation, and the final consumption tell the story of all but a very minor portion of social activities. Back of all of them is the machinery of social forces and motives, the names of which (imitation, suggestion, etc.) we have already canvassed.

In our further discussion of social facts we shall work under two main headings: "The Self as Social" and "Social Institutions." In the study of the former topic we shall attempt to secure a thorough understanding of the social individuals whose behavior makes the social institutions. Under the latter topic we shall describe briefly only customs and mobs, leaving aside other topics of great importance such as religion, law, and morality.

A. THE SELF AS SOCIAL

The Place of Instincts in Social Life.—Any thorough account of the self must include a study of instincts because these are the fundamental forms of all behavior. By virtue of his membership in the species each individual possesses certain characteristic inherited modes of acting called instincts. Here belong such responses as fear, anger, joy, sorrow, grief, jealousy, gregariousness, acquisitiveness, food-getting, sex responses, etc. Once again, as in the chapter on "Animal Psychology," we must postpone the detailed consideration of instinct to Part II, and continue to think of it in the fairly general sense of any inherited form of response in animals possessed of a nervous system. The instincts are termed fundamental because all of the later developments in conduct (character) are composed of modifications of this original stuff of human nature. In a very true sense the entire field of psychology centers upon this question of adjustment to environment, whether the adjustment be inherited or acquired. In the process of change and growth that goes on in each instinct, social factors are always effective. I learn to fear what my neighbor fears. I secure my food and mate in the ways prescribed by social usage. My curiosity and jealousy are aroused and satisfied in the conventional manner prescribed by the group in which I live. Wherever one turns he is met by social guidance and compulsion. In this respect—and it is an important one—all instincts are social. One may,

however, consider the instincts not so much from the standpoint of their conformity to social standards (or vice versa) as from the point of view of the types of situations that arouse them or of the primary functions that they serve. From such an angle sex, gregariousness, jealousy, the parental instinct, fear, and anger are social in a way that hunger, curiosity, and joy seldom are. The former instincts are aroused in situations where other persons are usually integral parts. Even in the case of anger where the social element is less uniform, there exists an inevitable tendency to personify the offending object. The elusive collar-button and the threatening cloud alike tend to become persons at the moment of the arousal of the instinct. This is also equally true of fear. The latter instincts of our foregoing list are not so essentially social.

The chief importance of instinct for society lies in two directions: (1) The instincts furnish the fundamental driving-springs to action in the individual. They represent solutions for typical recurrent difficulties as they have been worked out in the past history of the species. Customs, traditions, conventions, fads—all must take this fact into account. These habits are built upon the basis of instinct and represent habitual modifications found desirable by the group of individuals. Thus marriage in its various forms is built upon the basis of the sex and parental instincts. Customs of food production and distribution involve the instincts of hunger-satisfaction, rivalry, acquisitiveness, etc. These modifications and elaborations of instinctive responses are transmitted from generation to generation by education, i.e., by social as opposed to physical heredity. (2) Not only do instincts represent the fundamental responses made by an individual to certain situations that constantly recur within his lifetime, but furthermore they are types of behavior that cannot be eliminated. One may repress or modify an instinct so that it seldom recurs or so that it appears in a highly modified form, but one cannot eradicate the instinct

totally. Social customs and usages, when they are successful, recognize this fact. The sex instinct cannot be eliminated or successfully repressed. The Middle Ages saw the failure of such a doctrine, and Freudianism at the present time is contributing further data. Hostility, jealousy, rivalry, and the other instincts are likewise permanent features of the organism's behavior system. Social groups can modify but cannot destroy these tendencies. Hostility may be sublimated from sheer animal attack as in war to the more subtle conflicts or competitions of wit and cleverness; yet ever and anon the repressed animal form of the combative instinct comes to the surface and dominates behavior. Indeed we might proceed to trace in detail not only the place hostility assumes in social life, but also the places that the other instincts occupy, whether they be essentially social or not. We must turn, however, to an account of three forms of behavior that have a peculiarly significant position as socializing forces.

Socializing Influences in the Individual.—

1. *Sympathy.*—Sympathy is fellow-feeling. It is, when strictly defined, more than a mere cognitive appreciation of the emotions of another. To sympathize one must himself experience the emotion of another to a greater or lesser degree. To sympathize with joy, anger, fear, and sorrow means that the observer himself is aware of similar emotions from perceiving them in others. The term sympathy, therefore, designates a certain relationship between the emotions of two or more individuals, and does not refer to a particular feeling or emotion in one person. The relationship, accordingly, can occur only in a social situation. Its importance in the development of society has been stressed by Giddings (1905) in particular. It is important to note that sympathy not only depends upon a conscious interstimulation or social arousal, but it usually comes forth only when individuals of a kind are involved. The greater the similarity of the organisms the keener the sympathy.

A man may project personality into his dog or his horse and share its feelings; but ordinarily sympathy is the stronger between man and man. Its greatest value lies in its function as a powerful cohesive factor among members of a group.

Two forms of sympathy may be distinguished: passive sympathy, which gets no farther than the bare experiencing of similar emotions, and active sympathy, which, as Bain points out, leads its possessor to act out these emotions in behalf of another as though they were in reality his own. It is this latter form that is socially meritorious and adaptive. To see a neighbor in pain and distress is certain to arouse distressing emotion in the normal person. The passive type hurries on with averted face, or quickly turns to more pleasing topics in the paper, if the emotional situation has arisen from reading. Such an individual erects a defense mechanism of inattention and forgetfulness. The active type responds with aid if the situation is painful, and with joyful acclaim if it is pleasant. The differences between the two are due in part to custom and convenience, and in part to the individual's innate organization by virtue of which he may be chiefly interested in self. Much passive sympathy exists from sheer lack of sufficient energy to meet actively all of the demands made upon one's fellow-feeling.

Both forms of sympathy depend for arousal chiefly upon two factors: (1) one's experience in the past with such joys and sorrows as now demand sympathetic response; and (2) the consciousness that the individual to be sympathized with is a member of one's own kind. Both, therefore, wait upon one's power of imagination. (Imagination, let it be said, is here given its popular meaning.) It is difficult to sympathize fully with abject grief unless one has suffered it himself. The woes of poverty and the pangs of hunger can at best strike but a feeble response in the continuously prosperous and well-fed.

The influence of the second factor is equally clear and perhaps even more striking. Our inability to sympathize with some distant and unfamiliar group of people is largely due to our inability to appreciate clearly their similarity to ourselves. They are strange and unknown and we cannot well vividly portray their human characteristics, the deep human nature that makes the whole world of man akin. (There is, of course, the opposite fault which leads one to sentimentalize the convict and the international offender.) Our enemies, those hostile not only to me personally but to my clan, tribe, or group, those who are not for us, we explicitly place outside our "kind." Such limits as imagination sets to sympathy are both good and bad—bad to the extent that worthy persons are excluded from the sphere of fellow-feeling, but good to the extent that they enable one to keep a hostile and uncompromising front to otherwise likable people who persist in violating international and social laws. Immediate face-to-face encounters with suffering individuals act as so powerful a stimulant to sympathy that the aims of justice, which must be rational, are often deflected. A criminal or one who has broken custom and is cast out of the group is not only an offender; he is also a man and a former member of the group. The sympathy aroused by the stimulus of the latter fact may succeed in offsetting the non-sympathetic responses to his antisocial actions.

The problem raised by the question of sympathy is essentially that of the place of emotion in social life. Emotions possess the great function of uniting by powerful associations the objects which are experienced with them. Two individuals (two persons, or a man and his dog) who pass through the same emotional situations are in the future bound together with "sympathetic" ties. They become, by virtue of that fact, henceforth members of a kind, of a clan, of a group.

2. *Imitation.*—Among sociologists Tarde and Baldwin in particular have stressed the influence exerted over the conduct

of the individual by imitation. In general to imitate is to duplicate the actions of another, as to sympathize is to duplicate the feelings of another. The child imitates its parents. One sparrow imitates another by flying when the other flies. The adult person imitates others in his conformity to fashions and conventions. It must be clear, therefore, that imitation may involve a greater or lesser degree of consciousness and a greater or a lesser amount of reasoning. There is no valid ground for assuming that imitation in animals involves rational processes. In a pack of wolves one animal sets up a howl and the rest chime in. In a flock of birds one flies and the rest follow. Terror in one member of a herd will stampede the entire group. These are the so-called cases of instinctive imitation, i.e., cases where one individual is said to be aroused to perform an act x by perceiving its occurrence in another animal. These are the most primitive forms, the most widespread and automatic forms of imitation. There is no minimizing its importance in the preservation of the group through its effect upon team work and uniformity of action. Cattle that did not stampede after their leaders would in time fail to survive. Social groups whose members did not act as other members act would disintegrate. This is all true, and yet there is little ground for the assumption of an *instinct* of imitation. Such a statement assumes that by heredity one or more instincts may be aroused not only by dangerous objects (fear), or by annoying objects (anger), but by the perception of the instinct itself as it occurs in another. Thus to speak of an "instinct of imitation" is to say that by heredity the awareness of fear in another arouses fear in the beholder, the awareness of anger itself arouses anger, etc. But the awareness of fear in another may arouse joy, shame, anger, or almost any other action in the beholder. The fact that fear is often contagious does not indicate that fear is itself the stimulus which brings about its spread throughout the group.

The keenest criticism of such a point of view we owe to Thorndike (1913). He writes:[1]

> The spectators of an infuriated man, or of two men raging at each other, are not thereby provoked to similar acts and feelings. They manifest rather "curiosity-wonder," forming a ring to stare, the world over. So with other mammals. When Professor McDougall wrote that "anger provokes anger" he probably had in mind the fact that angry behavior of A toward B provokes angry behavior of B toward A. But that is irrelevant to his purpose, since he surely does not wish to contend that A's fleeing from B makes B flee from A, that A's shrinking from B makes B shrink from A, that A's self-abasement before B makes B abase himself before A.

The whole difficulty lies in making sure in any particular case of imitation whether the similar responses are not due to the fact (1) that each animal concerned receives the stimulus that affected the first or imitated animal, or (2) that the imitated behavior itself contains a signal or stimulus for its repetition by others. So Thorndike continues:[2]

> Under present conditions children would usually learn by training to run from what others ran from, to look at whatever others looked at, and the like, even if there were no original tendencies to do so. Moreover the object or event, the perception of which causes A to respond by a certain instinctive behavior which then spreads to B, is likely to be perceived by B also, so that whether his behavior is a response to A's behavior or to the object itself is often in doubt. For example, A's fear at a snake may arouse B's fear indirectly by merely calling B's attention to the snake. Finally A's response may, upon his perception of B, be modified to include certain behavior which acts as a special signal to provoke approach, fear, or whatever the response may be, in B. Thus the danger-signal might be given by A when frightened in company, though not when frightened alone; and B might respond, not to A's general fright, but to the danger signal.

[1] E. L. Thorndike. *The Original Nature of Man* (New York: 1913), p. 119.

[2] *Ibid.*, p. 120.

We are unable to point out the exact mechanism by which all cases of imitation are brought about. In the chapter on "Animal Psychology" we had occasion to present a typical experiment upon rational imitation in monkeys. In this form of imitation the individual is supposed consciously to conform his actions to those of the imitatee. We indicated at that time that the monkey's behavior was understandable in terms of two factors, (*a*) the heightened interest due to the presence of a second member of the same species, and (*b*) the focusing of the animal's behavior, or attention, upon the essential features of the problem. The fact that man and many animals below man do act as they perceive others acting is beyond doubt. The reasons for this form of response will vary with different situations, as we have indicated in the quotation from Thorndike and in the discussion of animals. Perhaps the strongest reason for imitative activities in general lies in the sense of helplessness, loss, and fear that comes with the isolation from (non-conformity with) the group. Later in the discussion of custom we shall meet certain of the methods adopted by the group to compel conformity to, or imitation of, its ways.

3. *Suggestion.*—Suggestion is the third factor upon which particular stress has been laid in explaining the social behavior of the individual. It is difficult and unnecessary to keep it separate and distinct from the imitative process. Ordinarily suggestion is defined as the process of uncritically accepting an idea that is encountered in social situations; but the line which separates that which is accepted and believed from that which is merely performed in common with others is exceedingly fine. Sympathy, imitation, and suggestion all refer to uniformities, to similarities among individuals of a kind. In all cases the arousal of the feeling, act, or idea in the second person proceeds in a manner practically automatic and unconscious. One hears the cry and is instantly sharing to some extent the sorrows of his neighbor. One sees his friend's new spring suit, and with little

or no deliberation procures one of the same style when it comes time to buy. One reads that his country has made a great contribution toward the winning of the war. "The wish is father to the thought," and the idea is uncritically welcomed with open arms. The similarity between the three processes is partly based upon the intimate connection between consciousness (or better, the neural activities accompanying it) and action. To sympathize is to feel as your neighbor does, but this involves no inconsiderable amount of similar responses or imitation. The same is true of suggestibility. It is but a short and fairly inconsequential step from belief in an idea to action in accordance with that idea. If the idea is shared by two or more individuals, the action will be shared likewise and is then termed imitation.

We have already encountered the phenomena of suggestion in our study of abnormal psychology. Suggestibility is favored by any factors that tend to put the critical powers of the individual off guard and that permit an idea to obtrude itself into consciousness with little or no critical consideration. Resistance to suggestion goes along with a wide and highly organized experience. As a result, women, children, and members of the more primitive races are in general more open to suggestion, to the uncritical acceptance of ideas, than are men, adults, and the more cultivated races. We may follow Ross, in the main, in listing the factors that aid suggestion: prestige, age, race, sex, emotional excitement, repeated stimulation, and the feeling of being but one person out of many. By prestige we refer to the effect of authority in securing the unresisting acceptance of an idea. Let a high critic of art pronounce a picture poor, and immediately for many the picture is no longer artistic. Let custom through some of its representatives say that such and such conduct is wrong and the edict is unquestioningly accepted by most people. I write an account of suggestion, and the students more or less uncritically accept it as true because as a

writer of books I have prestige and authority! This factor is a valuable and unavoidable aid in the dissemination of ideas among a group of people, the chief safeguard, however, being that the prestige emanate from ability. In many cases prestige depends upon the age, race, or sex of the leader; thus we may group these factors as subordinate ones under the main one of authority. Insistent, insidious repetition will also break down and overcome resistance and cause ideas to be accepted as correct. Familiarity breeds acquiescence. The effects of the other two factors, emotion and numbers, we may best illustrate under the topic of mob action to be discussed below.

The Nature of the Self.—Under the present topic we shall consider the self only as it appears in consciousness. In a very true sense the self is identical with the individual organism. From this point of view an account of the self would involve a discussion of all its characteristics as an individual apart from, though related to, other individuals. Psychology as a whole is the study of the individual's consciousness and behavior. Consequently, the entire account of the present book is directed toward drawing the outlines of the individual in so far as he may be subject to psychological analysis. The present section, however, deals only with a very limited part of the topic, viz., the nature of self-consciousness. In our discussion we shall follow along the road mapped out by James.

I am, it is true, a part of all that I have met. But within my total consciousness there are certain elements that are more intimately and peculiarly "me" than others. My body is probably first. It is represented in consciousness fundamentally as sensations from the muscles, skin, and viscera. These sensations persist from moment to moment and form a major portion of the consciousness of continued bodily existence. Organized in this manner and supplemented by memories of the past, they may be termed the bodily-self. There is also a self-as-others-know-me which includes my awareness of

myself as I think others believe me to be. It may be quite different from my self-as-I-know-myself. Then there is the club-self, the religious-self, and in fact a self for each of the fundamental situations of life which I have been accustomed to meet. James states the situation as follows:[1]

> *In its widest possible sense,* however, *a man's self is the sum total of all that he* CAN *call his,* not only his body and his psychic powers, but his clothes and his house, his wife and children, his ancestors and friends, his reputation and works, his lands, and horses, and yacht, and bank account. . . . . *Its own body, then, first of all, its friends next, and finally its spiritual dispositions,* MUST *be the supremely interesting* OBJECTS *for each human mind.*

Each of these fairly numerous selves has a certain distinctness and individuality. Each is an organized unit dominated first by the standards of conduct applicable to the specific situation, and second by the awareness or consciousness of itself as in that situation. Ordinarily and normally all of these selves are so closely interrelated that they are felt as one. Yet when my club-self is dominant I tend to forget and ignore what I am as a professor-self and vice versa. So the week-day-self forgets or ignores the Sunday-self. These forgettings are defense mechanisms erected by the dominant self to save it from self-criticism or from other inconvenience. Ordinarily the amnesia (forgetting) is not so complete as to be termed pathological. Occasionally, however, it may be so, as we have seen. Then we have the cases of multiple personality, i.e., extreme splits in a normally slightly divided self. Freud has taught us to hold that the exaggeration in the amount of division is due to a relatively strong need for a defense mechanism.

The Development of the Self.—Each of the selves that we have so briefly mentioned is changing from the time of its initial inception to its final death. This change may be either

[1] William James. *Principles of Psychology* (New York: 1890), I, 291, 323.

a growth or a decay. Perhaps few of the average individual's many selves continue their existence until the time of his bodily death—in fact the bodily-self is the only one that usually does so. The content of this self—interest in the welfare of the body as represented largely through kinaesthetic, cutaneous, and organic sensations—as a rule changes but little. As opposed to this instance the contents of one's social selves are in constant flux. The child's family increases, decreases, and varies in its many fortunes. Likewise does one's family as a man. The circle of one's friends and acquaintances is now large, now small, now intellectual, now plodding. With the average individual (at least in the cities) this fluctuation in content is incessant. It is more difficult to generalize in the case of that social self termed the religious. Many individuals find this content stable and unvariable. Others are tossed about for most of their lives upon the thorny beds of religious unrest, repudiating first this and then that content, refusing to be an orthodox self, rebelling at an unorthodox self, and perhaps never reaching a decision. This religious-self after its first appearance in early childhood persists throughout the greater part of the physical lifetime of the individual. Undoubtedly few if any normal human beings exist after childhood who do not place themselves in relation to a power greater than themselves. The content of such a religious-self will vary widely, depending upon whether the individual conceives this Greater Power as Absolute, as only superhuman, as spiritual or material, as solicitous or indifferent, as good or evil, etc. The content of this self will include all of one's behavior and standards governing that behavior so far as it involves a relation to this Power greater than the self. It should now be stated in amplification of our foregoing comments upon the bodily-self that, although normally it is the most persistent and lasting self, instances do at times arise where it is totally repudiated in the interests of a social self. Asceticism is the attitude which dominates when the

bodily-self is denied and destroyed so far as consciousness is concerned. Extreme cases are on record where apparently hardly a vestige of interest and concern for the bodily-self remains. The social self which thus more or less totally excludes any other may be a religious one or it may be a devotion to the more secular ideals of justice and fair play. The successful growth of any of one's selves involves the adjustment to or elimination of its other competing selves.

What we have just written can be best illustrated from James:[1]

> I am often confronted by the necessity of standing by one of my empirical selves and relinquishing the rest. Not that I would not, if I could, be both handsome and fat and well dressed, and a great athlete, and make a million a year, be a wit, a *bon-vivant*, and a lady-killer, as well as a philosopher; a philanthropist, statesman, warrior, and African explorer, as well as a "tone-poet" and saint. But the thing is simply impossible. The millionaire's work would run counter to the saint's; the *bon-vivant* and the philanthropist would trip each other up; the philosopher and the lady-killer could not well keep house in the same tenement of clay. Such different characters may conceivably at the outset of life be alike *possible* to a man. But to make any one of them actual, the rest must more or less be suppressed.

These competitions between the selves of a given individual contain the great dangers of mental maladjustments as well as the possibilities of spiritual growth. Social conditions, as we have seen, require the repression of certain possible selves. Too often this has meant an attempt to distort essential human nature. In those who fail to work out a *modus vivendi*, who are unable to adjust their impulses to social demands without doing themselves violence, mental disease appears. They become the neurotic, the hysterical, the obsessed.

Baldwin on the Growth of the Self.—So far, in our sketch of the development of the self, account has been taken only of the

[1] William James. *Op. cit.*, I, 309–10.

variations of content in the various selves. Baldwin has described in addition certain phases that each self passes through in its attitude, particularly, toward the corresponding selves of other individuals.[1] Not only will my club-self vary in its content from time to time so long as it exists, but it will take certain attitudes toward the club-selves of others. Two attitudes of chief importance are to be distinguished, which Baldwin calls the *subjective* and the *ejective selves*. The subjective self is the self as submissive, as imitative—a learning self. As ejective the self is aggressive and masterful, putting into practice that which it has learned as subjective. I enter a strange club. Its ways and customs as embodied in the club-selves of its members, the standards by which it governs conduct, are all as yet unknown to me. As a new environment in which I am to move, it has prestige. I am thrown into a submissive attitude. I observe. I move respectfully. I note and learn. Then having mastered the new situation, having expanded my club-self to take in its new surroundings, I change my attitude from that of a novice to that of a habitué. My manner becomes easy and masterful. I unconsciously read over into the club-selves of my fellow-members the pleasures and motives that I now find within myself. I now "eject" that which has hitherto been subjective. One may follow through in a similar fashion subjective and ejective attitudes of the many selves in a thousand and one situations. We cannot here discuss, but it is interesting to note, the fact that the submissive self is dominated by a mild emotion of fear and the ejective, or aggressive, self by a mild anger. Selfhood and also fear and anger are essential to each individual.

B. SOCIAL INSTITUTIONS

Introduction.—By a social institution we shall mean any of the more or less stable and permanent relationships

[1] We shall here rather use Baldwin's contribution than attempt to give an exposition of it. The present account therefore varies considerably from the original.

entered into by individuals. Society itself is a social institution. We mentioned others at the beginning of our present chapter: fashions, conventions, traditions, the mob, the crowd, the public, religion, morals, law, language, art, etc. It should be clear that only part of the individual is involved in each institution. One self will be found particularly emphasized in fashions, another in morals, another in religion. It would far exceed the scope of our present bird's-eye view of the field of social psychology to discuss many of these topics in detail, for each in turn calls not only for an analysis of structure, but also for a survey of the factors causing constant changes in this structure. Accordingly we shall limit our present account to brief comments upon the nature of custom and the mob.

The Nature of Custom.—Customs are uniform modes of acting that are transmitted by social heredity from generation to generation. Thus one finds religious, moral, commercial, legislative, and other customs. They differ from ordinary habits in that their age extends back of the present generation and in that they are habits common to a large number of individuals. Like habits (see the discussion below, p. 176) they arise partly by chance and partly as a result of reflection. Perhaps in each case both factors are active, varying only in relative amount. Particularly in primitive customs does chance play a dominant rôle. Let us describe a hypothetical but typical case of custom-formation in hunting, remembering that the securing of food is a matter of tremendous importance in primitive life; that strong emotions are involved; and that as a matter of life and death the savage can afford to ignore no power that may aid him. On the morning of the hunt he comes from his shelter with his bow and arrows and stumbles. The day proves unfruitful. Stumbling becomes an omen of bad luck, a thing to be eliminated from the procedure of hunting. In like manner the full moon may also become associated with poor hunting, and the custom be confined largely to the dark

of the moon. If failure attends the hunting for several days and then gives place to success shortly after the hunter has rubbed the bow three times and said to himself, "O arrow, shoot straight," this practice becomes incorporated into the hunting procedure, is taught to the hunter's friends and children, and finally becomes a well-established custom. As growth occurs, some customs are cast off and their adherents are termed non-believers. Present-day society is replete with such vestigial modes of acting. "Do not plant potatoes in the dark of the moon." "Do not pass a pin without picking it up." "Thirteen is unlucky." These useless and more or less rejected customs rest upon a defective analysis of the relation of cause and effect in nature. The reason why the above injunction about potatoes does not influence most of us is that we can detect no causal relationship between growing potatoes and the phases of the moon. In a like manner the superstitions concerning the number 13, the spilling of salt, and many other acts and their supposed significance do not generally affect us. Among the more intelligent classes the tendency is to form all essential customs upon the result of reflection. For this reason laws are drawn up by deliberative assemblies. Rules of planting and reaping are devised at the agricultural colleges. Yet even with the most intelligent a fairly large field of behavior remains under the reign of chance impression, partly because—as with the number 13—the situations are not vital for the individual, and partly because some customs, such as religion, the control of sex behavior, the right of property, involve such tremendous issues that society fears to tamper with accepted custom lest great evil result.

What are the factors that give custom its grip on the individual's various selves? They may be listed as follows: (1) fear of the unknown and the unusual that are to be found just outside of the customary mode of action; (2) the ease, convenience, and lack of fatigue in doing the accepted; (3) the prestige of

the old; (4) the effect of public opinion. The more important the custom to the individuals concerned the greater is the influence of the first factor. The primitive man will not depart from his hunting custom or from his method of caring for his cattle, because to do so is to leave a successful form of response for untried possibilities with suffering and death the penalty of failure. Present-day peoples are loath to depart from the customary marriage regulations for much the same reason. It is to run the risk in this very important social problem of "jumping from the frying-pan into the fire." And then, too, in all of these cases it is much easier to act than to think. The path of the reformer is always hard and seldom attractive. The prestige of the old is the prestige of that which has worked well enough at least for survival. As a group, China with its ancestor-worship is perhaps the most striking illustration of this factor. Public opinion has its effect upon the individual partly through the great prestige and suggestive power that attach to large numbers and partly through the fear of ostracism and isolation that result from non-customary behavior.

The Mob.—Customs are relatively permanent social institutions. Mobs are very transient. Many selves may exist and never take part in social relations that even closely approximate mobs, while no self avoids custom. In a mob we have essentially a congregation of individuals dominated emotionally and intellectually by a certain situation. The particular self involved will depend upon whether the situation concerns the family, religion, or the club, for example. Suggestion and sympathetically aroused emotion are the great forces at work.

We may describe the nature of the mob in the following schematic manner: (1) The exciting cause, a murder, let us say, stirs the community deeply. Consciousness focuses itself definitely upon the details and upon the identity of the probable offender. (2) The news is spread that the offender has been captured and that the people are gathering in the town square.

This leads to a further increase of the crowd which at this stage is governed largely by curiosity. (3) In such a group suggestibility is at its height, due to the emotional status of each individual. The way is prepared for irrational mob action. (4) A leader appears and harangues the crowd. He fixes their attention further upon the details of the crime, arouses their emotions by playing upon custom violation and the need of awful punishment. Then with the group in a state of high tension, the leader, or some member of the group who thus becomes a spontaneous leader, shouts a demand for hanging the guilty one. (5) The suggestion catches and spreads. To have the idea is to act upon it.

In this schematic way we might follow the further irrational, suggestible, childish behavior of the group dominated in this manner by a single emotional idea, but the situation is too familiar to require more description. The case is essentially one of group hypnotism. One may draw similar illustrations from the fields of political conventions, religious revivals, etc., which reveal the same frailties of the individual in a crowd. Indeed never a year passes but one can find excellent descriptions in the newspapers of mob activities. In so far as they take the form of killing a victim, so far are they examples of the blind primitive animal-anger whose purpose is the annihilation of the opponent. In each mob situation an emotion of some kind is the dominant influence making for social unity.

Other institutions of society we must leave untouched and proceed to an even briefer sketch of racial psychology.

II. RACIAL PSYCHOLOGY

Racial psychology concerns itself with differences between races in behavior and consciousness. To what extent do the customs and other activities of races differ, and what are the contributing causes? To what extent do the conscious experiences of races differ, and why do they do so? What are the

relative abilities of different races when examined by the method of mental tests, or by a comparison of their respective institutions? The question in all of these problems is, "How will individuals vary in their different characteristics by virtue of their membership in different racial stocks?" These questions indicate clearly that the topic of racial psychology is related very intimately to anthropology and ethnology. Most of its facts and theories are, up to the present time, the fruits of investigators who are not primarily psychologists. The situation is in process of fairly rapid change now to the extent that mental tests are being applied, and in the future one may expect accumulations of facts bearing upon relative intelligence that have been subjected to the most rigid scientific standards. The most extensive data of a reliable nature at the present time consist: (1) of descriptions of the customs of different races with some suggestion of their geographical, economic, and social causes; and (2) of physical (anthropometric) measurements showing particularly differences in skull capacity and form. The great and fascinating field of primitive custom and culture we shall pass over, though in the preceding account of social psychology we have described a few of the factors underlying their formation and preservation. The topic here to be presented for the purpose of illustrating the concrete problems of racial psychology is that of racial differences in general ability.

Racial Differences in General Ability.—The general question of inferior races is not whether or not there are inequalities in racial attainments, for there is ample evidence that all are not favored sons. The essential problem is whether or not there are inherent differences in ability. The question we are raising is psychological and not ethical. Cannibalism, polygamy, and ancestor-worship may be thought to be inferior in moral worth to the corresponding practices of Europeans; yet it does not follow that the adherents of these customs are mentally inferior. They may be able to see, hear, smell, and taste as acutely as

we, and their powers of thinking may be of a high grade. On the other hand peoples, races, may share the same customs and culture and yet differ more or less in intelligence. There has been a very strong tendency to treat all racial stocks as inferior to the European partly because the present European has assimilated and outdistanced more primitive races, and partly because today the "lower races," i.e., Africans, Australians, American Indians, and others, vanish and fade before his advance. Boas (1901, 1911) and other anthropologists do well, therefore, when they point out social, economic, and physiological reasons for race predominance. Modern occidental contact with more primitive races no longer is one of assimilation and intermingling, but largely one of exploitation. Roman culture conquered its barbarous captors in the final end of the empire, but prior to that the Romans had mingled more or less freely with their colonials. The Mohammedans absorb the native peoples that are below them, while the Caucasians do so almost not at all. At the present diseases of civilization, e.g., venereal diseases and tuberculosis, attack the newly found races more than was apparently the case in earlier racial contacts and thus aid racial differences in survival. In evaluating the great spread of occidental control over the world, note should be taken that relatively high civilizations (e.g., those of the Aztecs and Incas) have existed among races now extinct. Granted that these races were 4,000 years behind in culture, yet when one considers this in comparison with the age of man, Boas points out that accidental causes and not mental inferiority may well explain the facts.

It has long been urged that many of the primitive races reveal their mental inferiority in their language. One mark of intelligence is the ability to detect sameness or identity in widely differing objects. This is the capacity for acquiring workable concepts or general notions. Primitive races, it has been said, make too many irrelevant distinctions. They may call a small

nut one thing and a large nut another, and yet may have no word for both. They are unable apparently to see that while the nuts are different yet nevertheless they are both nuts and very similar. Or again words will exist for many kinds of horses according to color, and yet there will be no general word for horse. In other words, so the criticism goes, primitive races have more words than ideas. It is this general point of view that Hocart (1912) criticizes most brilliantly, pointing out that a language must be judged not in terms of dictionaries but in terms of its suitability to a particular environment. The reason why one race will make many distinctions with certain objects and relatively few with others is because the former objects have many specific uses and the latter few. Let us illustrate by a quotation from Hocart:[1]

> The Solomon Islands possess a most useful nut, the kanary, which engrosses much of the islanders' interests and fills much of their existence. In those parts investigated by Dr. Rivers and myself they distinguished two kinds: the *vino* and the *ngari;* in our eyes it was merely a difference in size, and we might never have considered them otherwise than as large and small specimens had not the natives given us the two words. Yet closely related as they are, they have no common term. Had we proceeded no further, we might have ascribed this deficiency to an "incapacity for clearly apprehending identity in difference." But is it reasonable to suppose that an identity so glaring could not peep through the thin veil of differences? . . . . We found that from trifling differences sprang a host of momentous ones—technical, commercial, and religious: the seasons of the two do not coincide; they are gathered differently, because the branches of the *vino* will bear a man and the *ngari* will not; they are cracked differently; . . . . they are preserved differently; . . . . the two, in fact, are only identical in the kitchen, and therefore they have but one word for the roasted kernels and puddings of either.

[1] A. M. Hocart. "The Psychological Interpretation of Language," *British Journal of Psychology,* V (1912), 272, 275.

Again an illustration from the Fijian language will show the opposite side of the matter. Where the group takes no interest in certain objects, there it makes no fine distinctions—not because it lacks the mental ability, but because such distinctions would be useless in its social existence. In English—

a cock crows, a hen cackles, a pigeon coos, a jackdaw caws, other birds sing or chirp or warble, but they cannot cry as they all do in Fijian. Is Fijian therefore more advanced in ornithology? On the contrary, it is because they take no interest in birds that they have but one word. . . . .

So one might continue citing peculiar cases in different languages where ideas that we might regard as necessary are lacking and unnecessary ones are present. But one really need not go outside the English language. Every special field has its particular vocabulary. Experts in most fields regard those who cannot use their jargon as more or less inferior beings! The farmer, the horseman, the mechanic, the psychologist, all find it necessary to draw certain distinctions and to omit others. To most of us horses are all of a kind, and one rock is much like another. But the specialist speaks of mares and stallions, and of chalks and limestones and shale. Some environments make greater demands on their inhabitants than others and therefore stimulate various accomplishments, although the peoples concerned may be of equal ability. There is no question but that all men imagine, remember, think, and feel. All can see, hear, smell. There is little reason to believe that savages have more acute senses than civilized man. It is true that they hear slight sounds and see faint trails that escape the townsman; but he too can see and hear them if he will practice and be interested.

The chief differences between European stocks and the so-called inferior races will undoubtedly be found in general intelligence as revealed by mental tests of the kind described in the chapter on "Individual Psychology." Very significant

beginnings have already been made with particular reference to a comparison of whites and negroes in this country. This work, carried on by Mayo, Baldwin, Pyle, Ferguson, and others, including the army psychologists, indicates a significant superiority of the white over the black in general intelligence, i.e., in learning capacity, or ability to adjust to novel situations. Although the topic is of absorbing interest, it must be passed by without further comment, as must also such other essential problems of racial psychology as emotional control, morality, intermarriage, and birth- and death-rates.

Résumé of Part I.—Psychology, it will be remembered, is a science of human nature. And the purpose constantly before it is to understand just what a human individual is with particular reference to his behavior and consciousness. To gain this understanding one must consider what characteristics in this respect man has by virtue: (1) of his relationship to infrahuman animals; (2) of his relative ranking in ability in his particular population; (3) of the abnormalities that he is prone to share or to develop; and (4) of his membership in a certain society and a certain race. We have now completed a survey of these fields. It remains in Part II, "Normal Human Adult Psychology," to characterize man from the standpoint of those forms of behavior and consciousness which all men possess in a degree dependent upon the influence of those factors which we have just outlined.

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PART II. NORMAL HUMAN ADULT PSYCHOLOGY

CHAPTER I

ATTENTION

Attention and Selection.—In a general way everyone is familiar with the fact of attention. At one moment I attend to tennis, at another to eating, and at a later moment I concentrate upon psychology. Each time I am absorbed in pursuit of the particular event I have chosen. I glance over the landscape and note, not all details at once, but first the blueness of the sky, then the trees and their colors, a bit of a house here, and a rolling pasture there. It is said that my attention is moving over the scene before me. In order to understand, in order to learn and remember, I must attend to certain matters and not to others. I must select them and hold them in the focus of consciousness. The technical description of attention will vary with the angle of approach as follows: From the structuralistic point of view attention is not an activity but a characteristic of consciousness—its varying degrees of clearness. Those thoughts, objects, and emotions, indicated in our preceding illustrations, to which we attend become clearest, stand out above the other conscious contents of the moment in distinctness. From the objective or behavioristic point of view it would be said that that stimulus which controls the dominant activity of the moment is in the focus or center of attention. So a dog "attends to" his food when reaction to food is the dominant activity of the moment. From the point of view of activity or function, attention is often said to be the selective activity of consciousness. We voluntarily attend to this as opposed to that, i.e., we select the one and not the other. Attention, however, is not a directing agent or force which throws a greater or lesser degree of light upon an object as a man casts a

spotlight here and there. *Attention is the clearness into and out of which objects move.* As such it is coextensive with consciousness, although not all states of consciousness possess it in equal degree. Accordingly, there is really no such thing as inattention. Inattention to one thing means attention to another. Whether an object or content shall enter consciousness, and whether it shall be in the focus of attention, are determined by selective agencies other than attention and consciousness itself. Neither of these determines whether I shall hear a tone which is sounded or whether I shall pass it by. Neither can decide whether I shall notice the war news or the editorials, and it is beyond the power of either to select out and make me immediately aware of infra-red rays of light or of air vibrations above 50,000 per second. The conditions of selection lie in the organism and are partly a matter of the nervous system. Any other answer assumes that consciousness acts upon the body, a point of view which we cannot accept.

Selective Agencies.—Here at the beginning of our account of selective agencies the general rule may be laid down that those states of consciousness are clearest whose neural accompaniments are most active, i.e., stand in the focus of neural (cortical) activity at the moment. What neural processes shall occupy this position at any one moment will depend, furthermore, upon other neural conditions. A very loud noise attracts our attention at once, only by virtue of the fact, however, that instinctive or hereditary connections in the nervous system seem to facilitate the nervous processes aroused by such a noise. These statements will become clearer if we take up in a serial order the so-called conditions of attention. It will then be seen that the subjective conditions are the fundamental determiners of what shall enter the focus of consciousness.

Anatomical Conditions.—The conditions (selective agencies) which determine what state of consciousness shall enter the focus of attention are: anatomical, objective, and subjective.

The *anatomical conditions* are the limitations imposed upon consciousness—or upon neural activity—by the number and character of the sense-organs. Of all the transformations and transfers of energy that go on in the universe, only certain ones are reacted to by man and animals. At any one moment of time each organism is bombarded by innumerable stimuli. Ether-waves and air-waves of all ranges of frequency, pulls of gravity, changes in electric potential, etc., are the forces in question which may vary from moment to moment. It is these forces which constitute the environment in which the animal lives. The very conception of an organism's adjusting itself to its environment presupposes selection. At one moment it will react to light, at another to sound, and then to odor. This phase of its adjustment is absolutely determined by the number and nature of the sense-organs that the animal possesses. Sense-organs, as we shall see later, are merely points on the organism which are particularly sensitive to certain forms of energy. That we do not have more of them and different ones must be due to the fact that the sense-organs we have serve to select out or adjust us to those forms of energy which favor survival, which enable us to detect food and mates, and which aid us in determining locations that are injurious (painful), that are too cold or too hot, etc.

Objective Conditions.—Objective conditions are those characteristics of physical (external) objects and events by virtue of which these phenomena either (1) force themselves upon our attention, or (2) lend themselves most readily to attentive observation. The first condition covers many everyday facts. Intense sounds, bright lights, strong odors, tastes, and contacts, all tend to crowd themselves into the focus of attention. The same is true of moving things. Animals that feign dead escape notice, while a mouse that moves catches the cat's eye. Throughout the animal scale movement or change in the environment is irresistibly attended to. The movement need

not be visual. The notes that make up the melody of a song rise and fall in pitch. In this manner they change in relation to the accompaniment, and accordingly make the melody easily attended to or followed. The skin is more sensitive to movement than to the discreteness or separateness of stimuli. One can place the two points of a compass so close together on the skin of the forearm that they are sensed not as two but as one. Suppose that this distance is 1 cm. If now one of the points is moved over a distance of $\frac{1}{4}$ cm., distinct movement will be felt. A similar phenomenon occurs in peripheral vision, i.e., in the field of vision away from the immediate object upon which one's eyes are focused. If one holds his open hand far enough toward the periphery of vision so that it can be seen only as a blur, it will be noticed that, although the individual fingers cannot be seen, movement of any one of them can be clearly apprehended. This is confirmed by careful experimentation which indicates that the threshold for movement is lower than the threshold for discrete objects. The adaptive value of these facts for the organism is very clear, for moving things are likely to be either food, mates, or enemies. It is very probable that stimuli of great intensity, loud noises, bright lights, etc., get into the focus of consciousness as much by virtue of the fact that they are changes from preceding noises and lights as by the fact of their intensity. *Movement is the fundamental objective condition of attention.*

In addition to those characteristics of objects by virtue of which we feel forced to attend to them, there are other characteristics which enable us to attend accurately—the second objective condition which we mentioned above. These conditions have been carefully studied in the psychology of testimony. The problem is to determine the objective factors which condition not so much our attention to the presence or absence of a noise or other happening as our attention to the details of the event. Attention, as we have seen, is essentially selection and

discrimination on the conscious side. What objective factors favor the discrimination of parts within a given total event? First, the object must not be presented for too brief an interval of time, for opportunity must be afforded for the organism to adjust itself to the new situation. Second, the objects must not succeed each other so rapidly that they tend to fuse or mix together. Exactly how much time shall be given will depend upon the complexity of the object and the amount of detail to be discriminated. We shall have occasion to describe data bearing upon this point later under the discussion of the scope of attention.

Subjective Conditions.—Under the caption "subjective conditions" of attention we may list the following: instincts, habits, and the laws of association. The first two conditions rest upon the third—the fact that if two states of consciousness (or two forms of behavior) have been experienced together, when one reappears the other tends to follow. This we may term the fundamental law of association. Instincts are inherited associations, and they represent original, innate modifications of the nervous system by virtue of which nervous impulses flow over one system of pathways rather than over another. A loud noise occurs. It attracts my attention by virtue of the fact that it is a sign of possible danger and therefore a stimulus for the instinct of fear. We are by heredity attentive to objects connected with food, sex, rivalry, play, curiosity, anger, fear, jealousy, and the whole remaining gamut of instincts. If organisms existed devoid of the anger instinct, threats against life and property would not attract attention unless they were also connected with fear. Individuals in whom jealousy is dormant do not attend to certain events which are frequent stimuli for that instinct. The fundamental motives and interests are furnished by the instincts. This is inevitable, for they represent the solutions which have been found advantageous in the history of the race for certain important difficult situations, dangers, and other problems of primary importance.

The term habit covers customs, peculiarities of education, and individual idiosyncrasies. Habits are built up by the individual with the inherited forms of action as a basis. They serve to limit further the lines of action taken by the organism, to fix more definitely the objects in which he as an individual is interested, even as the instincts set the limits of his interest as a member of a given species. Where the habits are passed from one generation to another by training, we speak of custom and tradition. It is a familiar fact that customary and traditional manners and beliefs are the things we hear and see, are the objects to which we attend. This is so to the extent that our behavior and consciousness follow the socially accepted (selected) pattern. A carpenter starts to build a house or a cobbler to mend a pair of shoes. Each attends to first this object, then that, and then the other, because that is the traditional way to build the house or to mend the shoes. A Chinaman's attention is attracted to the conservative phases of action and to the avoidance of outsiders, because this is a customary mode of behavior in these matters. Perhaps language is the greatest custom of all. This "idol of the tribe," as Bacon would say, fastens itself on all men to some degree, for little comes into the focus of attention that is not named. A faulty vocabulary notoriously limits our thoughts and curtails the things to which we attend. In addition to these habits shared with other members of the social groups, there are those which arise peculiar to the individual or to the small group. These are the hobbies and professions of men. Objects to which we attend as psychologists are overlooked by others and even by ourselves when we are masquerading as laymen. The objects constituting an athlete's world are quite diverse from those making up the environment of a judge, and these differ much from those of other professions. A geologist sees things that escape the eyes of ordinary mortals, and so the story goes. Each habit acquired determines new interests in terms of which objects will be selected and will enter the focus of consciousness.

We turn now to a brief statement of the part played by the laws of association in conditioning attention. The basic principle has already been stated—the fact that, if two states of consciousness have been experienced together, when one of them again enters consciousness the other tends to follow. These laws are not forces mental or physical, but are formulations of relationships detected between successive states of consciousness and between their parallel neural processes. If at one moment the letter *a* is in the focus of my consciousness, *b* tends to follow. This may be due to the frequency or the vividness of the association between the two. It may be because *b* arouses the same emotion that accompanies *a;* for it is a familiar fact that when I am gloomy, gloomy thoughts crowd in upon me, and when I am in a joyful mood only the pleasant things get audience. The selection of what I shall attend to is begun by the structure and functions of my sense-organs, is further completed by instinct and habit, and is then finished by the influence of the states of consciousness (neural activities) that have occupied the focus of consciousness the moment before. The action of each of these factors is conditioned by that of the ones that have preceded it in the list. The factors are listed therefore in the order of increasing variability, going from the anatomical through all stages of the subjective. As the individual organism ages, however, customs become as rigid as instincts, and the latter as inflexible as the sense-organs themselves in admitting novel stimuli to the focus of attention. Here one has the almost rigid personality, where no new ideas enter. Figure 15 represents graphically this hierarchy of conditions or selecting factors.

Accurate Attention.—Interesting experimental data have been obtained bearing upon the influence of subjective factors in testimony, or accurate attention. These tests have been most fully developed by the German psychologist Stern. The tests consist in the presentation of objects or events to one or

more subjects for description and report. The conditions of the experiment are varied in such a manner that it is possible to determine among other things the effect upon the range and nature of the report of: the duration of the stimulus; the presence of surprise in the observer; the age and sex of the observer; and the presence of definite expectations or goal ideas. We shall now comment upon these factors briefly, so far as they deserve additional comment. Attention is most

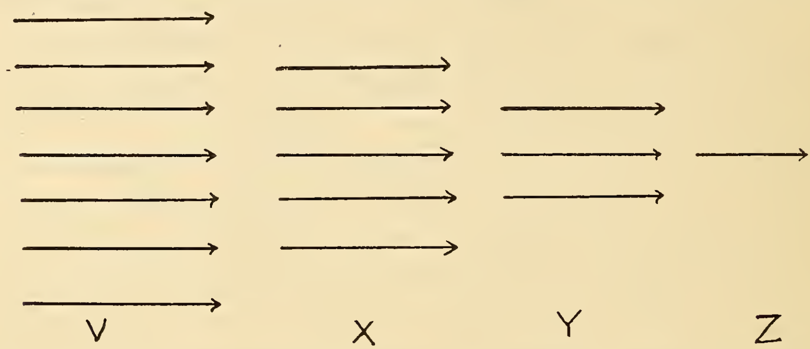


FIG. 15.—A diagrammatic representation of the conditions of attention. *V*, forces outside the nervous system (they may be inside the body) which may or may not affect the sense-organs. *X*, anatomical conditions of attention, the limited numbers, kinds, and capacities of sense-organs. *Y*, conditions of attention such as habit and instinct. *Z*, the last condition of attention, the neural activities immediately preceding any given moment of attention.

efficient if the observer is not fatigued and is not surprised by the sudden advent of the experience to be described. Surprise is an emotional disturbance, and emotions narrow attention to the particular stimuli that arouse them. Surprise thus draws attention away from the thing to be described and puts it on the characteristic of "unexpectedness" and on the bodily (organic) reactions of the observer. Again, trained observers, i.e., artists, scientists, report those features of the object which are in line with their calling. With untrained observers Stern has found evidence that the features of the experience described

vary with the age of the observer. Thus, persons and things are mentioned at the age of 7 years. From 7–10, actions are also noticed. From 12–14, spatial and other relations are added, and after 14 come the qualities and properties of the objects. Color is one of the last things to be selected. With the increasing age of the subject those characteristics of an experience are noted which lend themselves to a logical or unitary interpretation of the experience observed. There seems to be no significant variation with respect to sex in tests of this type. Common observation would say that girls and women select out or attend to many objects that are ignored by boys and men. This, however, is a difference of training and not of innate organization.

By the influence of *goal ideas* above referred to we mean that those objects are most likely to enter the focus of consciousness which correspond to the ideas or expectations in the consciousness of the observer. If I am shown a picture for a few seconds and am expecting to see numbers or faint lines, these are certain to be attended to. At times these goal ideas are identical with what is termed in the study of thinking the *Aufgabe*, or problem at hand. The observer in an experiment is given certain instructions. He is thereby prepared to attend to certain objects and to pass others by. This preparation is interpreted psychologically as a certain *cortical set*, or preparedness for response, by virtue of which nervous impulses in harmony with it are facilitated.

Further Specific Problems in Attention.—So far in our account of attention we have been concerned with setting forth the general conditions which determine what states of consciousness, or what neural processes, shall enter the focus of greatest clearness. We must now study other phenomena of attention such as scope, duration, motor accompaniments, fluctuations, divided attention, and classes of attention. Let us be perfectly clear with respect to what we are about to study.

Describing the matter in terms of consciousness, we want to know how many objects can be in the focus at one moment. This is the problem of the scope of attention and of divided attention. Again, we want to know how long a given object can remain in the focus, or, stating the problem in another way, how long we can attend to one object (duration of attention). In studying fluctuations of attention an attempt is made to describe how objects even in the focus of consciousness fluctuate in clearness. We shall study the motor disturbances with particular reference to the explanation of these fluctuations. Let us consider first the scope of attention.

The Scope of Attention.—Sir William Hamilton was perhaps the first to cite an experiment indicating a limit to the number of objects that could be distinctly apprehended in a brief interval of time. Hamilton says:

> If you throw a handful of marbles on the floor, you will find it difficult to view at once more than six, or seven at most, without confusion; but if you group them into twos or threes, or fives, you can comprehend as many groups as you can units; because the mind considers these groups only as units, it views them as wholes, and throws their parts out of consideration.[1]

This experiment in its modern form is applied to visual attention by the means of the tachistoscope. Figure 16 shows a typical tachistoscope with a description of some of the cards used. The essential characteristic of the apparatus is its adaptation for presenting varying amounts of material, as shown on the cards, for brief intervals of time, one one-hundredth to one-fifth of a second. Such an interval is too short to permit counting, and so the span of attention is measured strictly. It has been shown that four or five objects can be grasped during the brief exposure. These objects may vary much in complexity. Four short words can be grasped as readily as four

[1] Sir William Hamilton. *Lectures on Metaphysics and Logic* (Boston: 1859), I, 177.

letters; four groups of two lines each (// // // //) can be grasped as readily as four single lines. The more significant the meaning that is applied to the material the more material can be apprehended; e.g., if words are arranged as a sentence more words will be apprehended than if they are shown as a

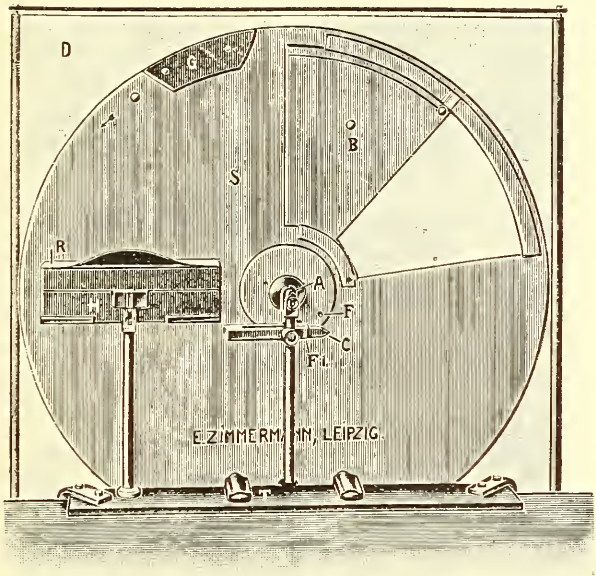


FIG. 16.—A rotary tachistoscope. The view shows the back of the apparatus. The screen *D* is between the subject and the rotating disk *S*. *B* is a movable sector by which the angular extent of the adjacent opening can be varied. The cards are held in *H* and are seen by the subject through an aperture in the screen when the opening in the disk moves by. The cards may contain words, numbers, lines, or any other material to be visually discriminated.

meaningless sequence. The truth of the matter seems to be that only one object can be attended to in any single moment. This object may be recognized as a complex or as a simple one. Experimental analysis shows that the apparent plurality of objects in the focus of consciousness is due to rapid processes of analysis and does not mean that all are grasped in the same

instant. This analysis of the one object into many objects follows the presentation of the stimulus in the brief interval while the experiences are still vivid. The momentary contents of the focus, therefore, and a unitary object are synonymous terms. Similar results are obtained with sound. Clicks that are given too rapidly to be counted group themselves on the average into spans of not more than eight. If, and to the extent that, rhythm is introduced within the span of eight, more and more sounds may be held in the focus up to thirty or forty.

There is no good evidence that "divided attention" exists. We attend to but one thing at a time. Those famous contemporary and historical personages who do from three to a dozen things at once, who dictate several letters and perform other tasks all at the same time, are not actually attending to all of these matters at once. Attention either shifts with great agility from one activity to another, or some of the activities are so automatic and habitual that they do not enter consciousness at all.

The Duration and Fluctuation of Attention.—In one sense we may be said to attend to the same object for many days or months. We may attend to the writing of a book, to the direction of a journey, or to the creation of a work of art. What is really happening of course is that we attend to the writing for a few hours only each day, and even during these few hours first one aspect and then another of the writing is in the focus of attention. In order to test out accurately the question of changes in the degree of clearness, it is necessary to work with relatively simple objects of low intensity. If one listens to a sound that is just barely audible (just above the threshold of consciousness) the sound will fluctuate in clearness every five or six seconds in spite of all the observer can do. The same thing is true if the object fixated is a very faint visual or tactual object. The object comes and goes in the focus. If the object is well above the threshold the fluctuations in clearness will be so

slight as relatively to pass unnoticed. In illusions of reversible perspective, such as the example in Fig. 17, the object is seen for a few moments as convex and then as concave. The fluctuations are a matter of interpretation or change in meaning.

Why do these fluctuations of maximal clearness occur? What changes are going on in the nervous system and sense-organs which determine them? Various answers have been offered which may be classified as *central and peripheral theories,*

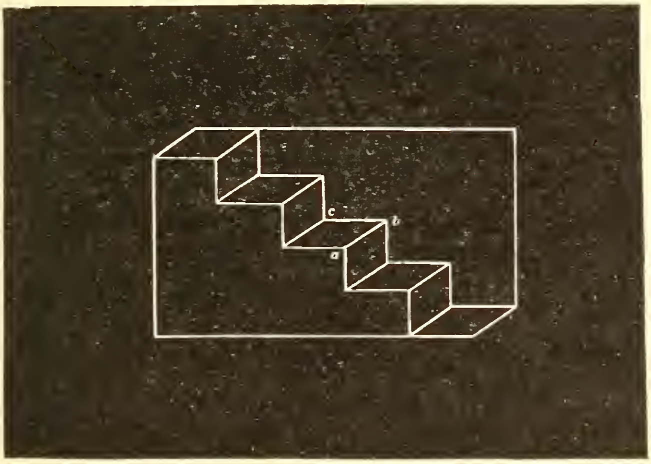


FIG. 17.—An illusion of reversible perspective (after Titchener).
The illusion consists in seeing the stairs sometimes as from above and sometimes as from beneath.

according as they attribute the essential conditions to the brain or to the sense-organs. Back of this type of explanation lies the larger question concerning the biological purpose or value of the fluctuations. This has been stated by Angell essentially as follows: Consciousness is concerned with the adjustment of the organism to its environment, with the solution of problems. Adjustment is a matter of detail; so that as each detail is disposed of, consciousness passes to another. The hypothesis, although alluring, has two apparent points of weakness. It would give consciousness an influence over bodily

activity; or, if it were so phrased as to escape this difficulty, it would still be unable to meet the second one, viz., the matter of the regularity of the fluctuations. Why should each process of problem solution occupy an approximately equal length of time? What seems a more probable answer, although an equally speculative one, is that the evolution of a highly complicated and delicately adjustable nervous system has evidently involved the appearance of one that is intrinsically unstable. This harmonizes well with the specific theory of explanation referred to above as the central theory.

Very strong argument has been brought forward to prove that the fluctuations are due to variations in the efficiency with which the sense-organs function. Thus the muscles of accommodation in the eye (or even the retina itself) may change through fatigue in such a manner as to decrease the clearness of the object in the focus. Influences of this type may often be effective, but they cannot by themselves account for the regular recurrence of the fluctuations. This is one important reason for not placing chief reliance upon the peripheral theory.

The central theory assumes that the fluctuations in clearness are due to the fatigue and recovery of cortical cells. It is supported by the observed fluctuations in ideas (images), illustrated by the reversible illusion (Fig. 17), by cases where sense-organs are not involved, and by the failure of peripheral theories to explain the facts. Furthermore, the regularity of the fluctuations lends support to the theory, for this regularity can be credited to certain waves of nervous excitation which originate in the medulla and probably spread to the cortex. These are the Traube-Hering waves of variation in blood pressure. Their spread to the cortex would result in alternate heightening and lowering of brain activity. The result of these waves, or rhythms of activity, in the medulla can be measured through the increase and decrease of the volume of the arm. These rhythms of increased pressure occur about

every six seconds and have been found to occur simultaneously with the fluctuation in attention. In certain instances similar variations in the breathing rhythm have been noted which also ran parallel with the changes in attention.

Classes of Attention.—The many instances of attention are usually grouped into three classes on the basis of the manner in which the feeling of effort is involved: voluntary, involuntary, and non-voluntary or spontaneous attention. At the present moment, e.g., the reader's effort is directed toward keeping the topic of psychology in the focus and keeping out of the focus all distracting influences. This is voluntary attention. If in spite of the effort a sudden noise breaks into the focus, the attention to the noise is termed involuntary. Other instances of this type of attention may be drawn from the field of imagery—an idea may haunt the mind continually after it is once encountered (fixed idea), or a tune may run in one's head constantly in spite of all effort to be rid of it. In the third form of attention the object which enters the focus of consciousness is neither aided nor opposed by effort. It appears spontaneously as in reverie and as in the cases of free association described in the account of psychoanalysis (p. 80). It is undoubtedly correct to regard spontaneous attention as the type present in the newly born animal or man. The nervous impulses that stand at the center of cortical activity, or, in other terms, the objects that enter the focus of consciousness, represent, not the product of effort, but the effect of innate nervous organization. Attention to the loud noise and to the bright light is spontaneous at this level because these events do not interrupt organized sequences of thoughts and sensations (objects). As soon as these organized plans and interests arise, voluntary and involuntary attention is clearly possible. When the young organism has acquired sufficient experience to choose and select, then that which interrupts or breaks in upon him is the involuntarily attended to object. This form of attention

is practically always unpleasant in varying degree, and is inseparably bound up with the emotion of surprise.

Unfortunately the terms voluntary, involuntary, and spontaneous do not lend themselves readily to descriptions of behavior where no reference to consciousness is involved. And yet distinctions of this type can be drawn with advantage between forms of behavior. For example, a dog is hungry and starts over toward his food bowl. This temporarily dominant form of response takes place unopposed and spontaneously. Now suppose that his master leaves the room and that because of the strangeness of the place the dog has a strong tendency to follow. Here are two opposite tendencies to response. If in spite of the impulse to follow his master the animal reacts to the food, the behavior situation is on a par with involuntary attention. So far as one describes this same situation in terms of obedience to the food-getting impulse, it is similar to voluntary attention. In like manner one may follow through cases in human behavior where responses are made to a simple situation and to situations involving competing impulses.

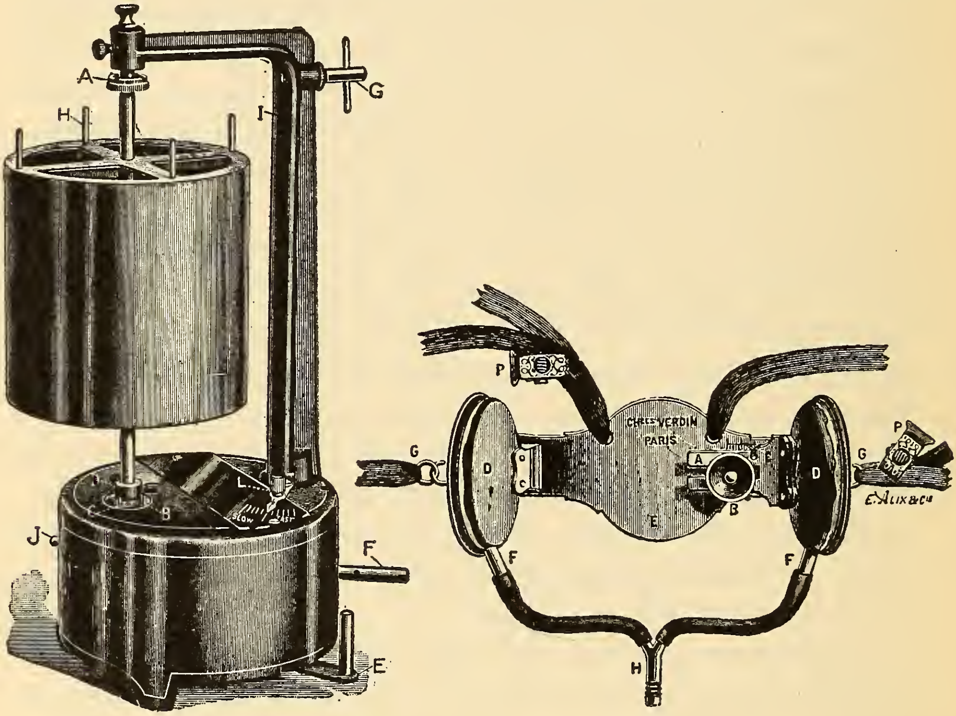
In concluding this section it may be said that a classification of attention such as we have just outlined is not a classification of different types of "clearnesses"; it is a division of attention on the basis of the relation existing between the content of the focus of consciousness (area of maximal clearness) and the awareness of effort. This awareness of effort is the conscious side of some of the motor accompaniments of attention to be described in the following section.

Motor Accompaniments.—If we concentrate attention upon a very faint sound there is an irresistible tendency to stop breathing, to tighten many muscles in the upper part of the body, to turn one ear in the direction of the sound, etc. These are the readily observable motor changes. In addition, there are probably adjustments in the muscles of the middle ear favoring more acute hearing, as well as changes in circulatory processes.

If the object attended to is a visual one of low intensity, there are, in addition to the general bodily disturbances of the type just described, other changes which serve to adjust the eyes for better vision. The eyes are focused upon the object; changes occur in the width of the pupil and in the shape of the lens; the eyes are turned in their orbits; and finally the brows are contracted. Changes of this nature which serve to make the sense-organs more sensitive are changes of *accommodation*. Other motor accompaniments of attention are the *non-accommodatory* changes. The tendency is for changes of both types to be absent in spontaneous attention, the characteristic motor attitude here being one of relaxation. It is undoubtedly this which makes spontaneous attention devoid of the consciousness of effort. The function of the motor accompaniments of accommodation has been stated and is readily understood. However, the function of the non-accommodatory changes is less easily seen. Undoubtedly they serve to arouse nervous impulses which facilitate (aid) those other nervous changes which are in the focus of activity and indirectly inhibit (oppose) any competing nervous activity.

A great many studies have been made of the circulatory and respiratory changes in an effort to correlate specific changes in them with the presence and absence of voluntary attention. Investigators have sought for these differences in the rate and amplitude of respiration and in the rate and character of the heart-beat. In these experiments the subject is seated comfortably and is given various problems in mental arithmetic to solve, or is asked to listen to reading, or is instructed to concentrate attention upon a given object, etc. It is important that no disturbances occur to interfere with bodily comfort or with the direction of attention. The apparatus used in the study of breathing is called a pneumograph and is shown in Fig. 18 in connection with the smoked-paper writing surface on the kymograph drum. The results obtained by this method

show great divergence, but they probably justify the statement that breathing tends to become shallower and more rapid in concentrated attention. In studying the circulatory changes a plethysmograph may be used, which is merely an air- or



A *B*

Fig. 18.—The apparatus *A* is a kymograph. The drum rotates at a variable speed and is driven by a spring within the base.

The apparatus *B* is a pneumograph. The tape at *G* and *G* is placed around the subject's body so that expansion and contraction will pull upon the rubber membranes attached to *D*. These changes are transmitted as puffs of air in the tubes *F*, *F*, and *H*. They finally reach a marker which records on the kymograph drum.

water-filled chamber into which the finger or hand may be placed. Pulse-beat and Traube-Hering waves may then be registered on the smoked paper of a revolving drum. Here again the results obtained are variable, but indicate that the

volume of the arm decreases with sustained attention (Stevens) and that the heart-rate increases (Shepard and Billings). However, much additional experimental work needs to be done in order to clarify the question of the part played in attention by these non-accommodatory movements.

Our brief account of attention brings us constantly back to the conception of the individual which was sketched above. We may think of each animal organism, whether man or below man, as a more or less independent unit played upon through the senses by various forces and as responding with muscular, glandular, and conscious activity. In adjusting itself to environmental demands, certain behavior must dominate at one moment and certain other behavior at the succeeding moment. This dominance and this variation are the behavior counterparts of what subjectively is termed attention. From the conscious side those objects are attended to which stand out in clearness or which dominate at a given moment.

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CHAPTER II

THE NERVOUS SYSTEM

The Reasons for Study.—Psychologists study the nervous system for three chief reasons: (1) Consciousness is intimately correlated with nervous processes. We have been reminded of this fact constantly in our study, and in the preceding chapter on "Attention" we were forced to turn specifically to theories and descriptions of nervous activity for explanations. At the present point we shall cite three typical cases of the relation of consciousness and bodily activity: (*a*) It is through the sense-organs and nervous system that such changes as air-vibrations, ether-waves, and chemical and mechanical impacts affect consciousness. The philosophers have termed this "the acquisition of knowledge of the external world." (*b*) Accidents to the nervous system, particularly to the brain, will change consciousness (cause loss of certain conscious states, confusion, etc.), or may even abolish it entirely. (*c*) Disease and drugs profoundly modify nervous conditions, and corresponding conscious changes take place. (2) A second reason for the study of the nervous system lies in the fact that the nervous system, by virtue of its continued existence, offers an explanation of much that occurs in consciousness. The instances of particular importance are those of learning and memory, i.e., of acquisition and retention—two phases of the same thing, because in order to complete learning it is necessary to retain the progress of the earlier stages. States of consciousness cease to exist the moment we are unaware of them. They are not stored away in some recess of the head or of the mind, thence to be recalled as occasion warrants. The accompanying processes in the nervous system modify the nervous tissue, and these modifications are

retained, a re-excitation of which reinstates the conscious experience. (3) The third reason lies in the fact that the nervous system controls behavior. Its function is the co-ordination of receptors and effectors.[1] Nervous impulses come in from receptors and are transmitted to effectors on the basis of connections or associations set up either by heredity or by the individual's own experience. In no other manner can the organism initiate activity.

The study of the nervous system is not a non-psychological study, for it cannot be divorced from behavior. Most researches made on the nervous system are made in the physiology and anatomy laboratories, not because all, or even most, of the results are non-psychological in character, but because few psychologists have the necessary training and interest to work in this field. This we shall see to be likewise the case in many studies of sensation.

The Neurone.—We shall begin our study with the neurone, which is the structural unit of the nervous system. It is composed of a *cell-body*, *dendrites*, and an *axone*. The entire nervous system is built up of cells many of which are these true nerve-cells, but many of which are supporting ones, *neuroglia*, non-nervous in function. Figure 19 shows typical nerve-cells and their attached filaments. A neurone differs from other cells in the body in that its special function is the conduction of energy, the nervous impulse. This function we saw on page 20 to be one of the general characteristics of protoplasm. Beginning students often get the impression that neurones are always microscopic in size, a condition that is frequently true. All are microscopic in diameter, but many of them are several feet in

[1] The term *receptor* is preferable to sense-organ because not all receiving structures connected with the nervous system arouse sensations or sensory processes. The term *effector* is more convenient than the phrase "muscles and glands." It refers to the structures that are aroused to activity by nervous impulses and that are connected with a motor nerve fiber.

length. One neurone, for example, extends from the top of the brain (pre-Rolandic area) to the lower part of the spinal cord at about the level of the first sacral vertebra (in the small of the back). Again one neurone may extend from the sacral

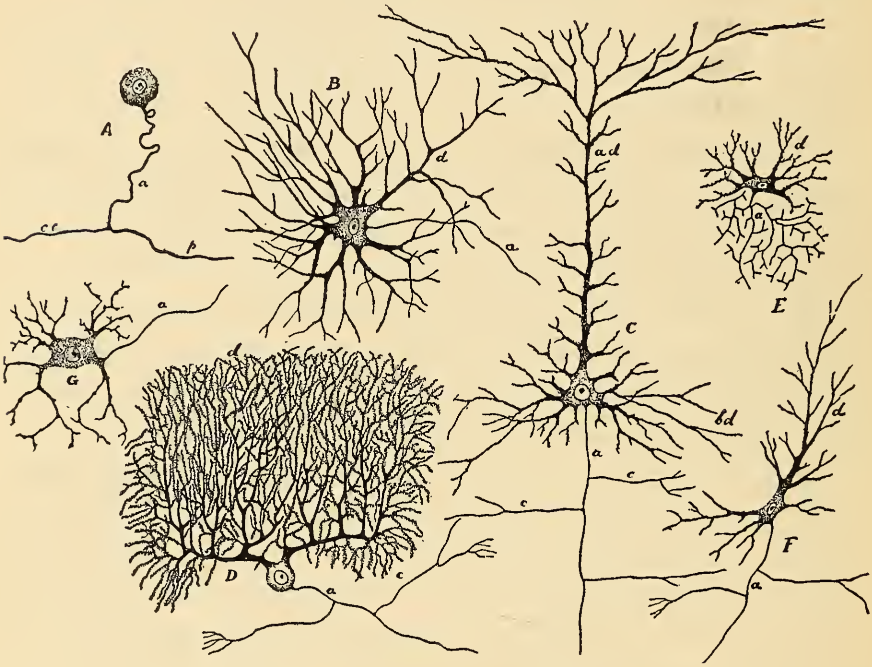

Fig. 19.—Typical neurones (from Morris)

"*A*. From spinal ganglion. *B*. From ventral horn of spinal cord. C. Pyramidal cell from cerebral cortex. *D*. Purkinje cell from cerebellar cortex. *E*. Golgi cell of type II from spinal cord. *F*. Fusiform cell from cerebral cortex. *G*. Sympathetic, *a*, axone; *d*, dendrites; *c*, collateral branches; *ad*, apical dendrites; *bd*, basal dendrites; *cc*, central process; *p*, peripheral process."

region of the cord to the tip of the toe. The cell-bodies themselves range in size from 1/160 to 1/6,000 of an inch in diameter; the axones, from 1/2,000 to 1/100,000 of an inch in diameter. As many as 100,000 of these latter may be bound together like a cable with connective tissue to form a *nerve*.

The cell-body contains at least two substances of great importance: the neurofibrils, shown in Fig. 20, and chromatin. The former extend out into the axones and may serve in the conduction of the nerve impulse. The chromatin (so named because of the ease with which it takes up the stains used in microscopic work) is intimately concerned in the metabolism of the neurone. When an animal has been excessively fatigued, microscopic examination of the cell-bodies shows that the chromatin has broken down and is scattered in small fragments throughout the cell-body. This is called chromatolysis (see Fig. 21). It sometimes even happens that the exhaustion is so complete that the cell-walls themselves break down and the neurone degenerates and is absorbed. The probable function of the cell-body is the nutrition of the neurone. It may incidentally slow down the transmission of the nerve impulses. In times past it has been regarded as the seat of ideas, as the most important part of the nervous system, and as the possible originator of many nerve impulses. It is still possible to view some sudden metabolic change in the cell-body as an occasional cause of nerve impulses.

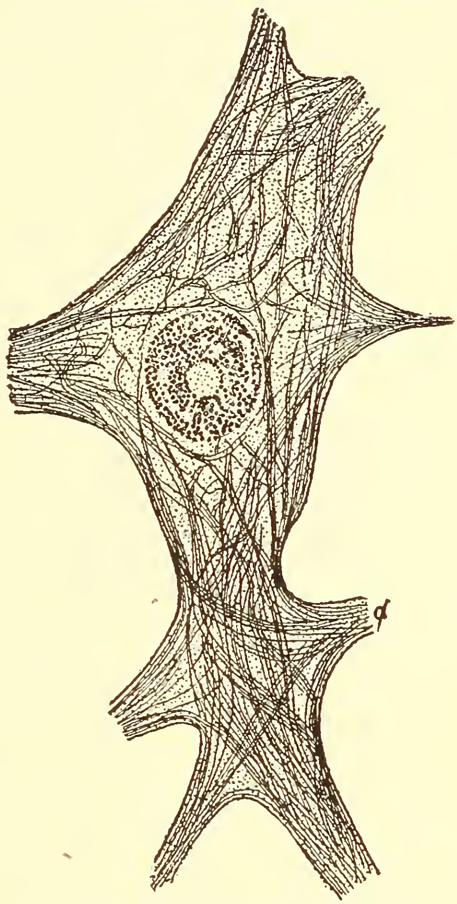

FIG. 20.—The cell-body of a neurone stained to show the neurofibrils (after Bethe).

The axone is *efferent* in function, that is, it conducts the nerve impulse away from the cell-body. Typically there is only one axone to a neurone, and it is smooth in outline, with branches at right angles. The dendrite is *afferent* in function, that is, it conducts the nerve impulse toward the cell-body. The number of dendrites per neurone varies from one to a great

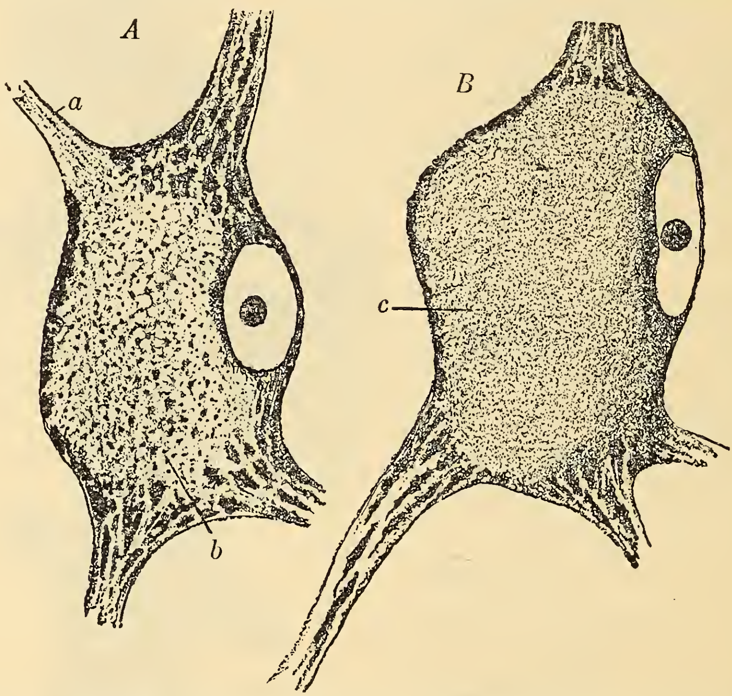

FIG. 21.—Cell-bodies of two motor neurones showing chromatolysis. *B* is the more advanced stage (from Herrick after Cajal).

number, and they are usually rough in contour with their branches at oblique angles. These facts are shown in Fig. 19, p. 134.

All axones of the central nervous system (see p. 144) and the dendrites of the neurones composing the spinal sensory nerves are covered with a *myelin* or *medullary sheath,* a fatty substance secreted by the neurone, Fig. 22. This sheath serves to insulate and support the inclosed *axis cylinder* and may play

some further part in the conduction of the impulse. It is white, and axones covered with it make up the major part of the "white" portion of the spinal cord and brain. The axones of the sympathetic nervous system (see p. 144) lack this covering and are gray in appearance. Those axones and dendrites that belong to the cerebrospinal system and yet lie outside the central nervous system (the fibers of the peripheral nerves) possess a second sheath, the *neurilemma*, which probably functions in the regeneration of a destroyed fiber, Fig. 22. If a motor nerve is cut outside the spinal cord, the fibers degenerate, and the person is temporarily paralyzed in certain muscles. The cells making up the neurilemma, however, do not degenerate. In the course of time a new nerve fiber is developed, and the paralysis disappears. If on the other hand the injury, or *lesion*, occurs in the spinal cord or brain where the neurilemma is absent, the pathway interrupted either never regenerates or else does so very slowly. In these cases the paralysis or the *anaesthesia*, loss of sensation, may be permanent. Where recovery of function does occur, it is most probably due to certain other structures taking over the function of the destroyed tissue (so-called vicarious functioning).

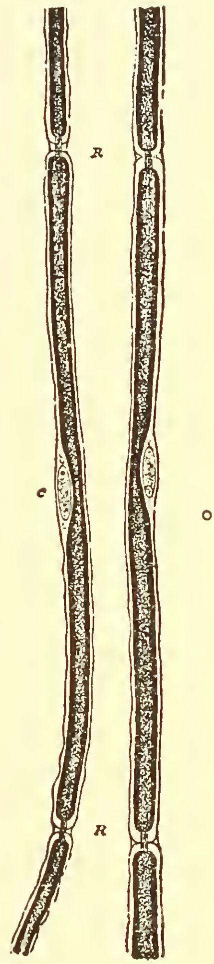

FIG. 22.—Fragments of two nerve fibers. The outer white layer is the neurilemma. The black sheath is the medullary one. The gray central portion is the axis cylinder.

The Reflex Arc.—The functional unit of the nervous system is the reflex arc. By this statement is meant that the reflex arc is the least segment of nerve tissue that can carry out the function peculiar to this system, viz., the correlation of receptors

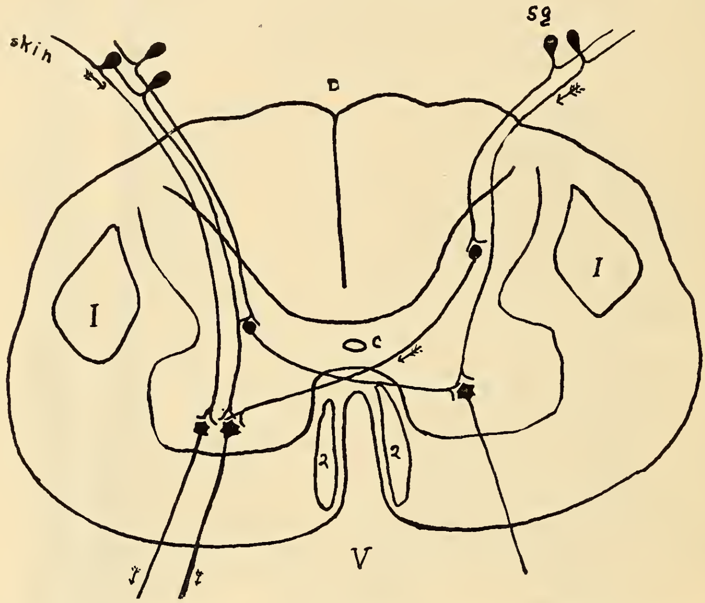

FIG. 23.—Cross-section of the spinal cord. The inner H-shaped figure gives the outline of the gray matter. The remainder is white matter. *D*, dorsal; *V*, ventral; *sg*, spinal ganglion; *c*, spinal canal; *1*, *1*, are crossed pyramidal tracts containing fibers from the pre-Rolandic area of the brain; *2*, *2*, are direct pyramidal tracts carrying the same type of motor nerve fibers from the brain. The crossed fibers cross from one side to the other of the cord in the region of the medulla. The direct fibers cross at lower levels. The arrows indicate the direction of the nervous impulse.

and effectors. The reflex arc includes at least two neurones and usually many more. It may be further defined as *any nervous pathway between a receptor and an effector.* Figure 23 represents a cross-section of the spinal cord and several simple reflex arcs. If more than two neurones are involved, all but the first and last are termed *association neurones.* The first

one is the afferent or *sensory neurone,* while the last one is the efferent or *motor neurone.*

The union between two neurones is the synapse. This connection is physiological (functional) and not anatomical (i.e., there is no tissue continuous from one neurone to the other). The figure above makes clear the statement that the determination of the pathway over which a nerve impulse shall pass is made at the synapse. In this figure the nervous impulse comes in from the skin to the spinal cord. Here it may go over either one or both of the two pathways. The direction which it does take depends upon the relative amounts of resistance encountered at the two synapses, for the impulse takes the path of least resistance. What the exact nature of this resistance is we are unable to say. It may be due either to chemical or to mechanical changes. Learning or habit-formation is synonymous with the elimination of certain pathways so that more and more of the nerve impulse is carried exclusively to a certain muscle or set of muscles. Intelligence, too, is largely a question of the particular synaptic connections that function in a given individual. An individual would not be rated as intelligent if a pain impulse resulted in such a contraction of the muscles as to lead to retention of the injurious object; nor is one intelligent whose muscles respond as a laugh when they should bring forth a sob. What response shall be made depends fundamentally upon the synaptic connections available, either as inherited and thus instinctive, or acquired and thus habitual. We shall canvass the factors underlying the setting or formation of these associations later in the chapters on "Instinct" and "Memory."

The Development of the Nervous System.—A glance forward to Fig. 25 will convince the reader that if any key to the complexity of the human nervous system is available it should be utilized. The development of nerve structures in the evolution of organisms and in the embryology of the individual

furnishes such a key. We have already seen the condition in protozoa, unicellular organisms (p. 20), where there is no structural differentiation of the system. The first important step for our purposes after this stage is the appearance of a diffuse nerve net such as is found in the jelly-fish. Impulses may start at any one of its sensory patches and pass in any direction to affect the muscles of the body and tentacles. Figure 24 represents a higher stage of evolution, the nervous

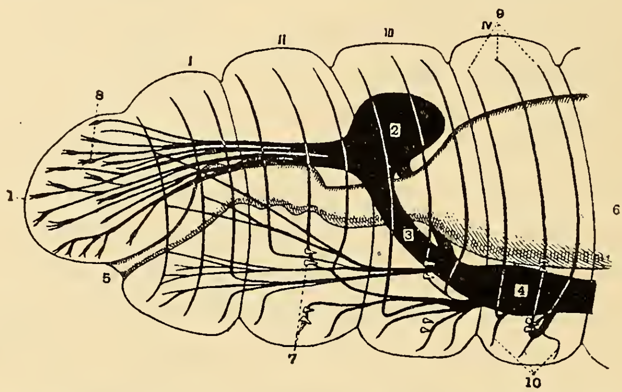

FIG. 24.—A lateral view of the nervous system in the anterior end of an earthworm (after Hesse from Shipley and McBride): 2, the brain or cerebral ganglion; 3, connecting bands of nerve tissue; 4, first ventral ganglion; 5, the mouth; 8, 9, 10, nerves.

system of the earthworm. In the anterior segment of the worm is a ganglion, or mass of nerve tissue, termed the brain. Below the alimentary canal lies the ventral nerve cord which duplicates in essentials of structure the spinal cord of man and other vertebrates to be described.

Provisions exist in the nerve cord of the worm whereby afferent nervous impulses may pass out immediately as efferent impulses or whereby they may pass up or down the cord a greater or lesser distance. The ordinary locomotion of the worm involves primarily short association neurones, whereas the sudden contraction of the whole body upon injury is due primarily

to the activity of long fibers. Yerkes has shown that simple maze-habits established by normal worms persist even after the head has been removed from the body. Apparently the chief difference between the normal and the headless worm lies in the less variable behavior of the latter. The evolution of the nervous system from the worm to man involves the following changes fundamental to behavior: (*a*) an increase in the complexity of the head ganglion or brain; (*b*) an increase in the number of long connections within the cord, making the cord more of a unit as opposed to the condition in the worm, where each segment is fairly independent; and (*c*) an increase in the mutual relations between brain and cord, a more complete unity of all nervous action.

The human nervous system is essentially a hollow tube much modified and enlarged at the anterior end. The spinal canal shown in Fig. 23 is part of the inner cavity of the tube and is continuous with the four large ventricles or cavities of the brain. The embryological development takes place in the following manner: Nervous tissue begins as a thickening in the ectoderm on the dorsal side of the embryo. This neural plate folds in, or invaginates, and closes over, thus forming the neural tube. At the anterior end three enlargements, primary vesicles, appear by an unequal thickening of the walls of the tube. From these three vesicles the brain develops by a series of outgrowths and flexions into the form to be described below. Along the main body of the tube or cord outgrowths occur which develop into the spinal nerves and into the sympathetic nervous system. Our discussion will now deal with the structure of the adult nervous system and the functions of its various parts.

Divisions of the Adult Nervous System.—The nervous system is composed of two main divisions: the *cerebro-spinal system* and the *sympathetic system.* The essential topographical relations of the two are shown in Figs. 25 and 26. The

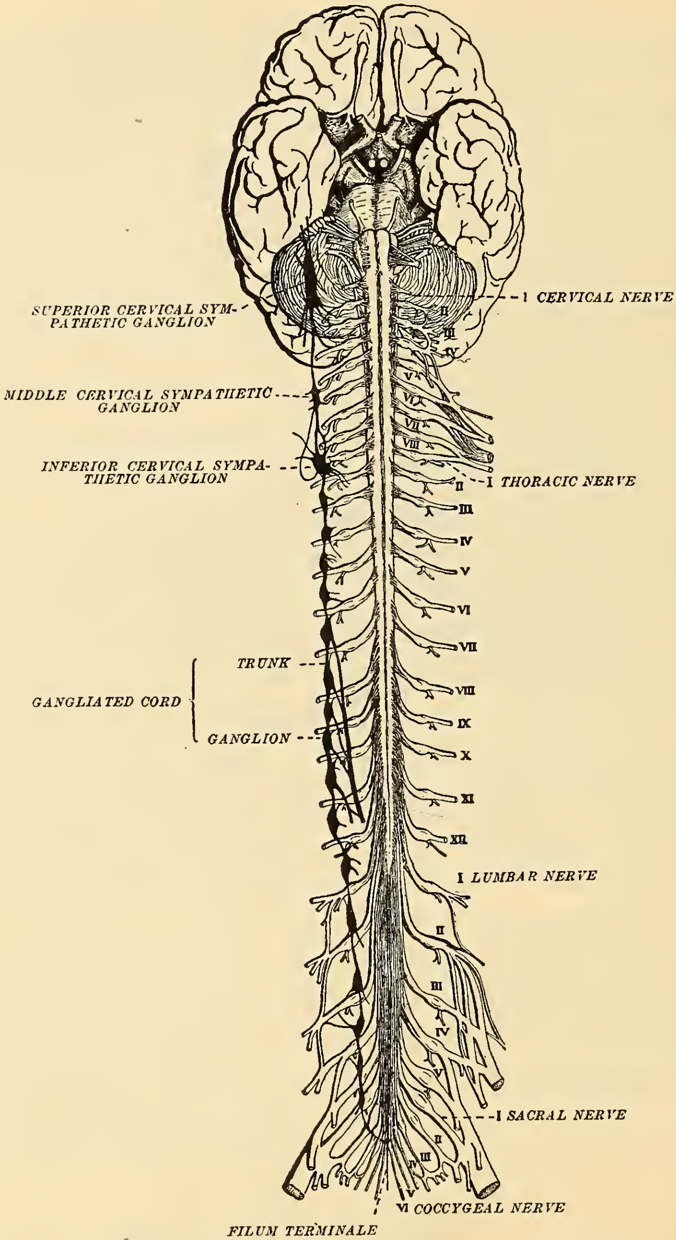

FIG. 25.—Ventral aspect of the major portion of the cerebro-spinal system, showing also one of the chains of sympathetic ganglia (from Morris). The numbers point out the 31 pairs of spinal nerves. The large mass of nervous tissue at the top is the cerebrum. The smaller dark striped mass is the cerebellum. The 12 pairs of cranial nerves are shown (unnumbered) above the spinal nerves.

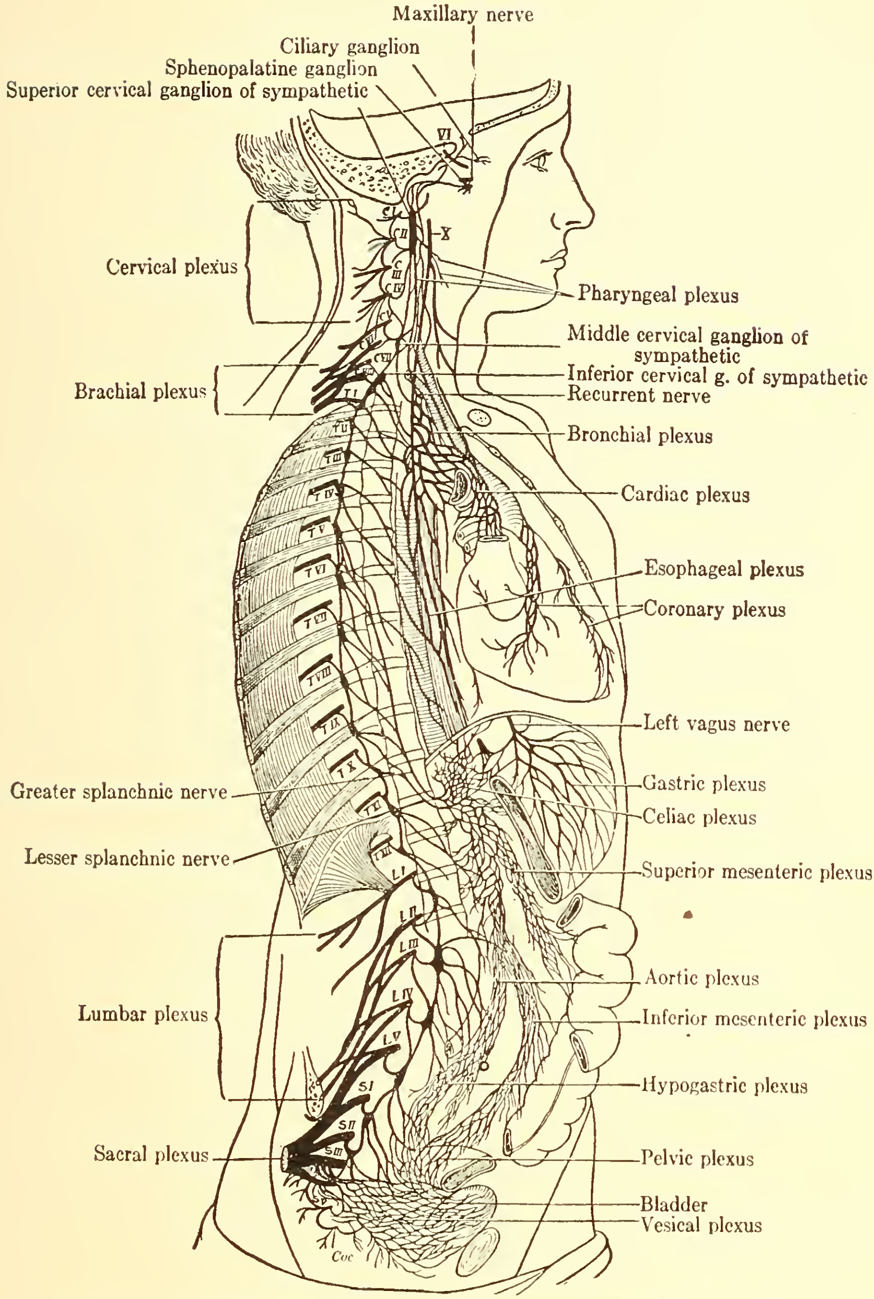

FIG. 26.—Showing the sympathetic nervous system in some of its widespread ramifications (after Schwalbe from Herrick). The Roman numerals again refer to spinal nerves (plus the VIth and Xth cranial nerves). The diagram also indicates the location of the chief parts of the nervous system with reference to the body in general.

sympathetic system, which is intimately connected anatomically and physiologically with the cerebro-spinal system, is composed of the following parts: (1) a chain of ganglia lying ventral to and on either side of the spinal cord; (2) three or four large masses of nerve tissue called plexuses lying in the body cavity and in close connection with the organs controlled; and (3) smaller ganglia scattered throughout the organism, in the eye-socket, in the thoracic cavity, on the walls of the heart, and elsewhere. Its function is the control of the action of glands and smooth muscles, activities such as the secretion of saliva, the peristalsis of the alimentary canal, and the variations in the tension of the arterial walls. In addition afferent impulses come from all of the viscera to sympathetic ganglia and often go on into the spinal cord. Here they may be transferred and reach the brain, giving rise in consciousness to organic sensations (hunger and intestinal distress) and transferred pain (headaches, for example, due to visceral disturbances). Some details of this we shall have occasion to consider in the chapter on "Sensation" (p. 215). It is in relation to the emotions, however, that the sympathetic system has its greatest significance for psychology, for, as we shall see in our chapter on that topic, organic disturbances are the factors of primary importance in our emotional experiences. The cerebro-spinal system includes the central nervous system and the peripheral nervous system. The former includes the spinal cord and brain; the latter is composed of the cranial and spinal nerves.

The Structure and Function of the Spinal Cord.—Figure 23 has already made us familiar with the cord in cross-section and with reflex arcs. A nerve impulse may come in over any one of the afferent fibers from some sense-organ in the skin, pass by association neurones to any other efferent neurone at the same level of the cord or at some other level, and from there go out to a muscle or gland. These afferent and efferent fibers at any one level of the cord are bound together to form the

spinal nerves, sensory and motor, of which there are thirty-one pairs. The sensory impulses that come in over these nerves condition kinaesthetic (muscle, joint, and tendon), organic, and cutaneous sensitivity in consciousness. Figure 27 illustrates a cross-section of the cord, showing extensive degenerations in the dorsal portion.

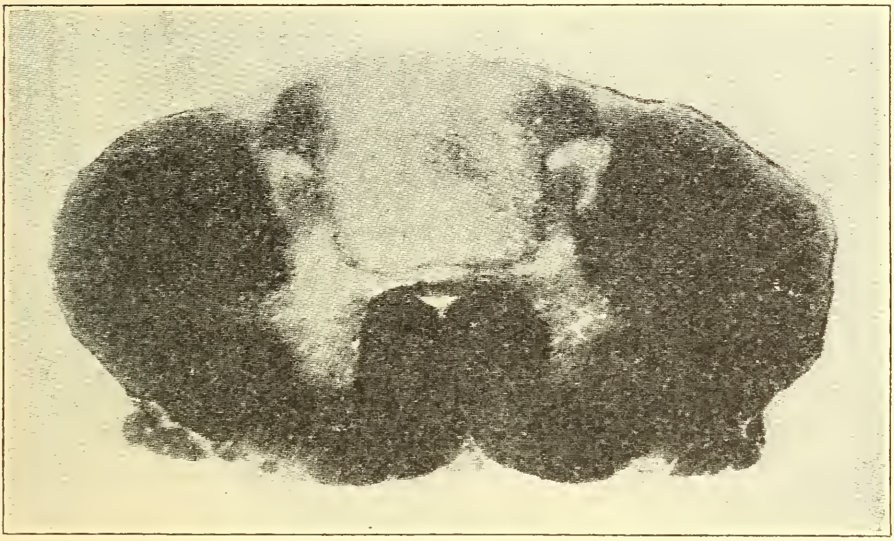

FIG. 27.—Degeneration changes in the spinal cord from tabes (from Jelliffe and White). Practically all of the dorsal part of the white matter has degenerated and is shown in lighter gray.

The function of the cord is: (1) to convert sensory impulses directly into motor impulses; and (2) to transmit impulses to upper or lower levels of the nervous system. We shall now indicate how these functions are performed by certain essential and typical structures. The cell-body of the first, the sensory, neurone always lies in the spinal ganglion,[1] while that of the motor neurone lies in the ventral or in the central part of the spinal gray matter. The gray matter of the cord is composed

[1] A *ganglion* is any group of nerve-cells outside the central nervous system.

largely of cell-bodies and unmedullated fibers, the white matter consisting of medullated fibers passing up and down the cord. Fibers and cell-bodies having similar functions are grouped together both in the white matter and in the gray, forming, respectively, fiber tracts and columns or *nuclei*. The only further detail we need mention is the location of the pyramidal tracts, crossed and uncrossed, which contain fibers originating from cell-bodies in the pre-Rolandic area of the cerebral cortex. Impulses pass down over these and produce voluntary movements of muscles. All of these fibers finally cross to the opposite side of the body from which they originate, so that the left side of the brain is connected with the right side of the body and vice versa. Sensory impulses passing to the brain go over certain definite pathways also, but they need not claim our attention. Any lesion due to accident or disease in these pathways in the cord results in such characteristic disturbances of movement and sensation as to enable the clinician to diagnose the location of the lesion fairly accurately. In locomotor ataxia, or tabes, for example, the germs attack the posterior columns of white matter (Fig. 27). As a consequence of the resulting loss of touch and kinaesthetic sensations, the individual is unable to control properly the movements of his feet and legs. Vision is therefore used as a guide, but even with this aid a characteristic gait is evident, caused by the absence of necessary sensory impulses.

The Medulla.—Figure 25 should be consulted in order that the student may have clearly in mind the mutual topographical relations of the parts of the brain, for we shall now deal with the second division of the central nervous system. The *medulla* is about one inch long and is a continuation of the spinal cord. Nerve impulses pass through it to the cerebrum and cerebellum as well as down it to the spinal cord. In addition it contains nerve centers[1] which control circulation and respiration.

[1] The term *nerve center* applies to any group of nerve-cells in the brain which has a definite function.

When the carbon dioxide content of the blood, e.g., becomes abnormally high, as in approaching asphyxia, this chemical condition acts upon centers in the medulla with the result that the heart-beat is increased in rate and respiration is accelerated and deepened. (We spoke of this above in an account of tropisms, p. 21.) Both cerebro-spinal and sympathetic nervous systems are involved in this action of the medulla.

The Cerebellum.—The *cerebellum* is composed of two hemispheres connected by the pons and bound by many fibers to the medulla and mid-brain. The chief function of this division of the brain is the maintenance of bodily equilibrium. To this end sensory impulses are received from the skin, muscles, and joints, from the semicircular canals of the ear, and from the eyes. The stopping of any of these classes of nerve activity interferes tremendously with equilibrium. We have noticed it already in locomotor ataxia. It can be shown by closing the eyes and attempting to stand without swaying, or in laboratory work by extirpating the semicircular canals of animals. If the injury is as great as the total excision of the cerebellum, the animal is entirely unable to maintain its balance. Impulses from the cerebellum serve also to maintain proper muscular tonus (contraction) and thus aid voluntary movement. It is probable that all portions of the cerebellar cortex, or outer gray layers, have the same function. So far no evidence has been produced indicating that consciousness is correlated with, or directly conditioned by, nervous activity in this cortex.

The Mid-Brain.—The dominant structure of this part of the brain is the corpora quadrigemina (superior and inferior colliculus), whose function is that of auditory and visual reflexes. Sensory impulses coming from the eyes (retinae) and ears (cochleae) enter here into synaptic connections with many motor neurones to the face, eyes, and other parts of the body.

The Thalamus.—The thalamus is a large mass of nerve centers lying in the center of the brain. All sensory impulses

go through some part of this structure before reaching the cerebral cortex, with the exception of certain impulses from the nose (olfactory membrane) coming over the first cranial nerve which arrive at the cortex by a different route. Clinical observations indicate that sensory impulses undergo much elaboration in the thalamus probably in the way of association with other afferent impulses so that a part of the neural correlate of conscious complexity arises before the neural excitement reaches the cortex (Herrick and Rahn). Studies of unilateral thalamic lesions by Head and Holmes have presented evidence that emotional and affective (pleasantness and unpleasantness) conscious states have their accompanying neural activity in the thalamus. Individuals with such lesions have excessive enjoyment of warmth or of concerts, for example, upon the affected half of the body. The evidence from this work further points to the general inhibitory influence of the nervous processes of the cerebral cortex upon those of lower portions of the brain.

The *corpus striatum*, a nerve center lying between the thalamus and the cerebral cortex, is another correlation center. Like the thalamus, it offers further opportunity for the elaboration of sensory impulses before they reach the cortex. In each case the sensory impulse may pass over a motor neurone originating in these correlation centers and a reflex act result without involving the cortex.

The Cerebral Cortex.—The neural processes which occur in the cerebral cortex comprise the major part—if not all—of those physiological activities which are directly correlated with consciousness. The remainder, if there are any, occur in the thalamus. The cortex is the highly convoluted layer (rind) of gray matter about 4 mm. thick which covers the cerebrum as a whole. Figure 28 shows this fact and also the topographical relations of the cortex to the other nerve centers which we have been describing. Unlike the cerebellar cortex, that of the

cerebrum is highly differentiated in function. Figure 29 names the primary lobes and their accepted functions. To designate the occipital lobe as the "visual center" means that sensory impulses from the retina of the eye reach this part of the brain

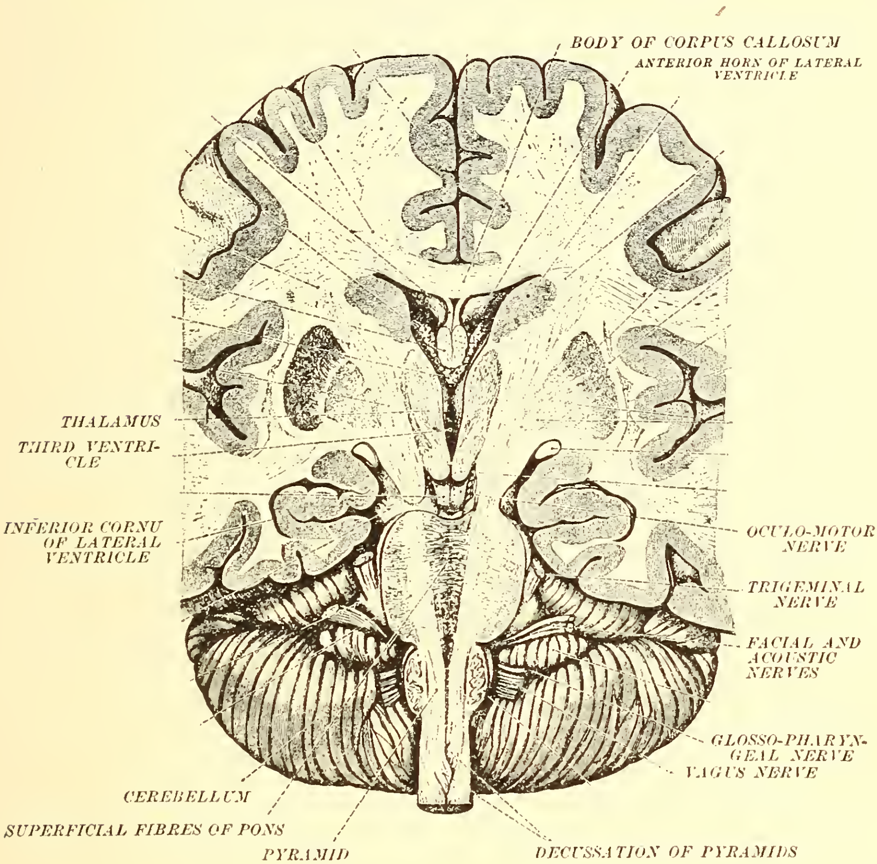

FIG. 28.—A vertical section through the brain (after Toldt, *Atlas of Human Anatomy*, by permission of Rebman Co., New York). Fibers are faintly indicated passing from the cord to various portions of the brain.

and that any disease or accident affecting it modifies visual consciousness primarily. Visual sensations and ideas (and the same applies *pari passu* to the other sensory centers) are not in the occipital lobe. They are wherever we are aware of them.

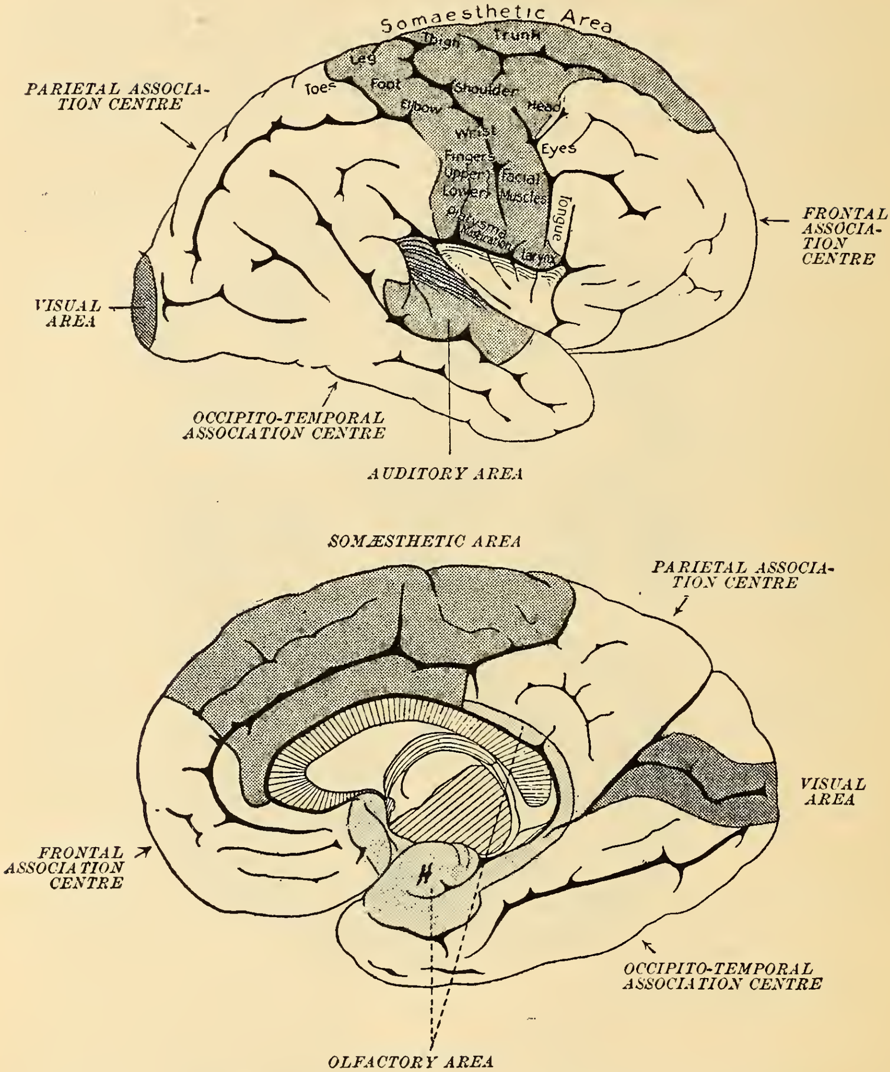

FIG. 29.—Diagrams of the two sides of the left cerebral hemisphere, indicating the localization of functions (from Morris). *Visual area* in occipital lobe; *auditory area* in temporal lobe; *H*, the hippocampal lobe. The *somaesthetic area* lies on both sides of the fissure of Rolando, the pre-Rolandic area being the area for voluntary movement and the post-Rolandic area receiving impulses for the skin, muscles, joints, tendons, and viscera.

Figure 30 shows the chief fiber tracts within the brain, in addition to which are innumerable smaller ones connecting adjacent parts of the cortex.

The following are the chief methods that have been used in mapping out the localization of functions which were schematically presented in Fig. 29: (1) The anatomical method

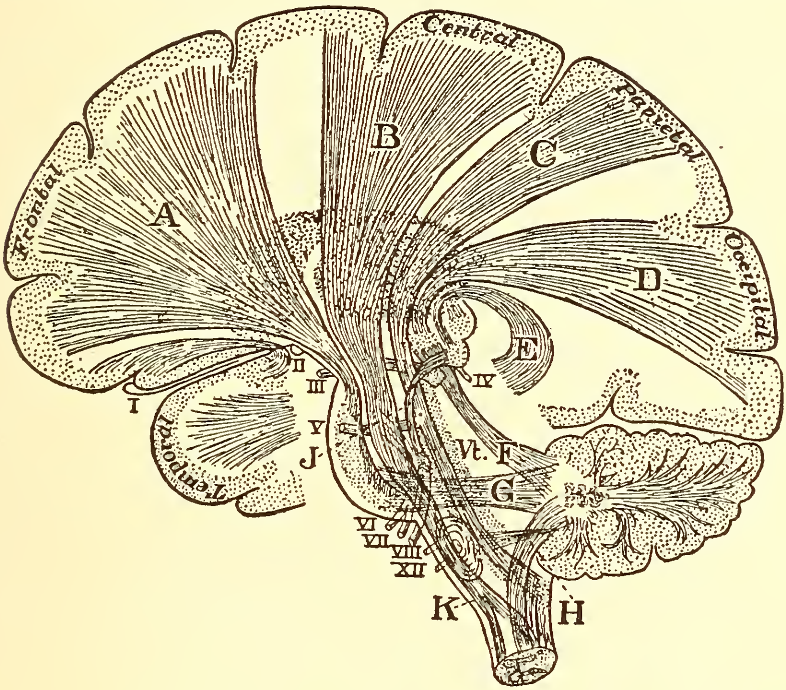

Fig. 30.—Chief fiber tracts in the brain (after Starr from Judd). The Roman numerals indicate the cranial nerves. The dotted mass in the center is the thalamus. Just anterior and dorsal is another mass, the corpus striatum.

is used in tracing the fibers from a given sense-organ to their ultimate cortical destination and from the motor areas to lower centers. Very important is the fact that degenerated nerve fibers stain differently from normal fibers and that fibers degenerate not toward but away from their cell-body. By experimentally sectioning certain tracts in animals and by observing

postmortem the effects of lesions in man, it has been possible to construct fairly definitely the functional pattern of the cortex. In addition to this fiber-degeneration method, there is the method of mapping cell patterns. The cortex contains many different types of cells which vary in the patterns of their relative distribution from one part to another of the cortex. Figure 31 shows a section from each of two well-marked cortical areas, the pre-Rolandic area for voluntary movement and the occipital lobe for vision. (2) The physiological method attempts to formulate the function of a given brain area by noting the effect of its activity upon the behavior of the animal. Parts of the brain are removed and modifications in the animal's sensitivity and motor capacity studied. This method gives more reliable results when applied to the determination of the motor areas, for here we can stimulate electrically the exposed brain of an animal and record the muscles which contract. Tests have been made on the exposed brain of man in certain cases, and results have here been obtained similar to those secured on monkeys and dogs. In one case it was even possible to arouse a cutaneous sensation in the hand by stimulating a portion of the post-Rolandic area (Cushing). (3) The embryological method of Flechzig studies variations in cortical areas on the basis of the varying periods at which the axones acquire their medullary sheaths.

It is not to be thought that these individual areas of the brain function as would separate units—the point of view held by the phrenologists Gall and Spurtzheim and their successors. When we refer to the superior convolution of the temporal lobe as the center for hearing, we mean that it is the focus of cortical activity produced by impulses from the VIIIth nerve, for the brain is active as a whole and not in parts. Consciousness at any one moment contains elements whose neural accompaniments are widely spread throughout the cortex. An interruption of the association pathways from any primary sensory

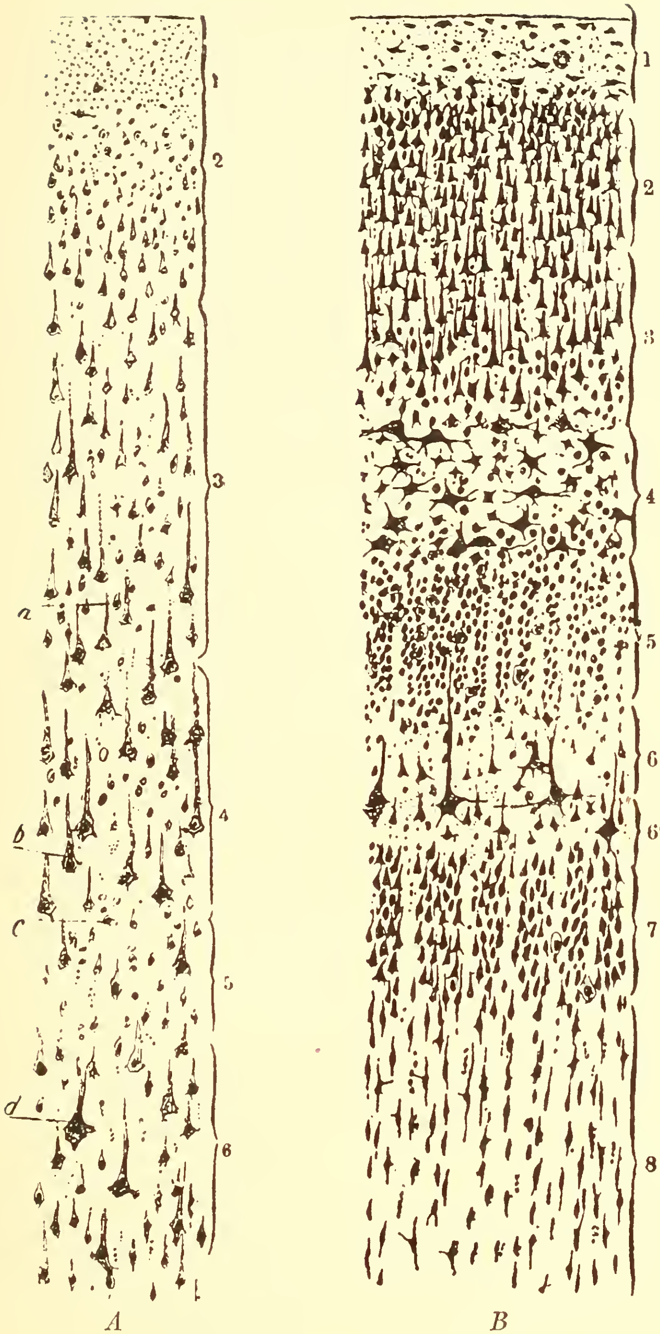

Fig. 31.—Sections from the cerebral cortex (from Quain after Cajal). The sections reveal great variations in cell pattern. *A* is from the pre-Rolandic area. *B* is from the visual area of the occipital lobe.

center with the consequent partial isolation of it from the rest of the cortex leads, on the conscious side, to the loss of customary meanings that attach to objects, and is termed *aphasia*. One may see and hear normally when so afflicted, but one cannot understand or identify objects.

The Cranial Nerves.—Twelve pairs of cranial nerves are given off from the brain, some of which are purely sensory, others purely motor, while others have both sensory and motor fibers. The points of origin from the external surface of the brain are shown in Fig. 25. These nerves are numbered from I to XII, beginning at the anterior end of the brain. The names and functions important for us to know at present are as follows:

NO.	NAME	FUNCTION
I	Olfactory	Smell
II	Optic	Vision
III	Oculo-motor	Motor and sensory to eye-muscles
IV	Trochlear	Motor and sensory to eye-muscles
V	Trigeminous	Sensory from skin, mouth, and teeth
VI	Abducens	Motor and sensory to eye-muscles
VII	Facial	Taste on anterior part of tongue
VIII	Auditory	Hearing and equilibrium
IX	Glossopharyngeal	Taste on back of tongue
X	Vagus	Motor and sensory to viscera
XI	Spinal accessory	
XII	Hypoglossal	

We shall study the functions of certain of these sensory nerves and their related receptors in much detail in the chapter on "Sensory Processes."

Important Groups of Conduction Paths.—In order to make the foregoing account of the nervous system significant, it is necessary that the reader actually trace out the schematic pathways followed by nervous impulses in simple types of behavior. Suppose, for example, that I see an object, volun-

tarily reach for it with my right hand, and then a sensory impulse is started, part of which causes me reflexly to grasp the object and part of which reaches the cortex and accompanies the con-

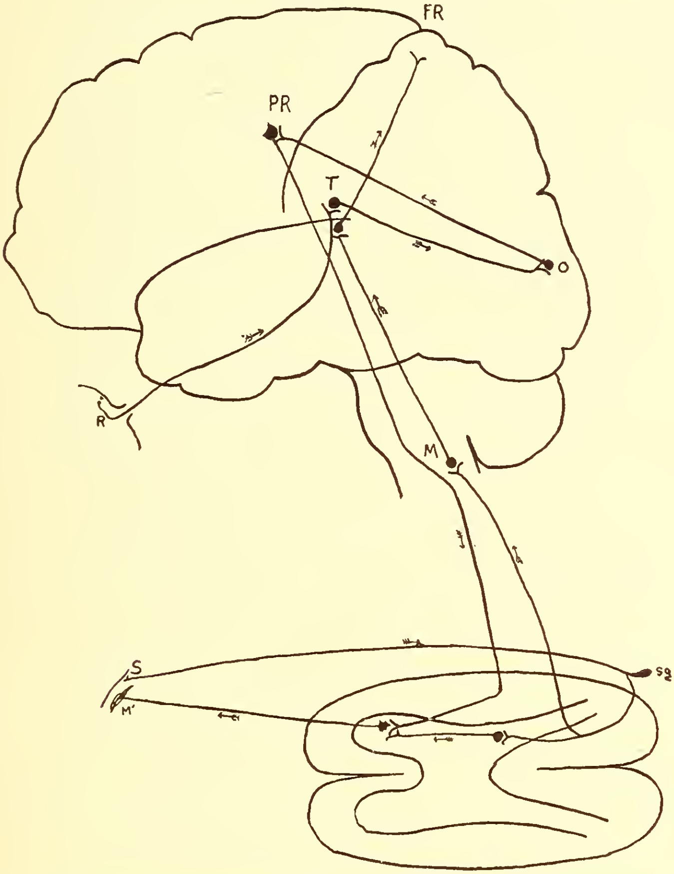

FIG. 32.—Probable pathway of a nerve impulse underlying a simple response. *R*, retina of eye; *T*, thalamus; *O*, occipital lobe; *PR*, pre-Rolandic area; *M'*, muscle; *S*, skin; *sg*, spinal ganglion; *M*, medulla; *FR*, fissure of Rolando.

sciousness of touch. What is the neural pathway followed by these impulses? The impulse (Fig. 32) starts in the retina, goes to the thalamus, thence to the occipital lobe, and I see the object. The impulse now passes over an association neurone

to the pre-Rolandic area, whence another neurone carries it to the anterior horn of the spinal cord at the level of the hand. Another neurone carries it to the muscles of the hand, and I have touched the object. Stimulation of a sense-organ in the skin starts an impulse over a spinal sensory nerve which enters the dorsal horn of gray matter. Part of the impulse passes into a cell in the ventral horn of gray matter on the same side and goes back to the muscle of the hand, and I reflexly seize the object. In the meantime part of the impulse has passed up the cord over one neurone and is then transferred to another in the medulla which carries it to the thalamus. From here a third neurone carries the impulse to the post-Rolandic area, and I am conscious of having touched the object.

In this fashion the reader can trace out many probable paths over which nerve currents pass, conditioning particular instances of behavior. It is important to remember the following points, which have already been presented, in order to make the constructions with the least difficulty: (1) the names of the lobes of the brain and their functions must be memorized; (2) all sensory impulses pass through the thalamus, save certain olfactory ones; (3) all motor impulses conditioning voluntary action originate in the pre-Rolandic area; (4) association neurones connect any two or more parts of the cortex; and (5) in the spinal cord sensory impulses always enter on the dorsal side and motor impulses always go out from the ventral side.

The hypothetical nervous activity diagrammed in this manner differs from what actually occurs largely in its greater simplicity. Many neurones are involved wherever one was mentioned above, and many associated neurones are active in the cortex, lending meaning to the conscious state where we have mentioned none. Wherever it is possible as our account of psychology proceeds we shall sketch the probable neural

processes concerned in the different activities. The student must remember throughout his work to correlate of his own accord, so far as possible, neural activities with the various phenomena of psychic life.

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CHAPTER III

REFLEX ACTION AND INSTINCT

Introduction.—We have encountered the terms reflex action and instinct in nearly every chapter that has preceded, for they stand as fundamental to any study of psychology. So far as the science is concerned with consciousness, we must recognize the part instinct plays in shaping motives of conduct, in determining emotional experiences such as fear and anger, and above all in constituting the basic factor which influences the content of the focus of consciousness. So far as the science of psychology deals with behavior, we must recognize that the elementary units of all responses of the animal are reflexes. Learning, habit-formation, and voluntary action are all combinations of these relatively simple forms of response.

Starting with the conception which we developed in chapter ii of the nervous system's serving to co-ordinate sense-organs (receptors) and muscles and glands (effectors), we might continue our study in either of two ways. We might start with sense-organ activities and follow through the topics of sensation, imagination, memory, and thought. Or we might begin on the motor side and work through the topics of reflex action, instinct, and habit, and then pass to the closely related topics of emotion and affections before taking up the sensory side. We have elected to follow this second plan for the reasons sketched in the paragraph above.

Definition of Reflexes.—In the topic of reflex action we are to examine the elementary mechanics of action. All behavior is a combination more or less complex of the relatively simple inherited activities of muscles and glands. Our brief examination is therefore the necessary prologue to the understanding of

instincts, habits, and intended (voluntary) actions. *A reflex act is a simple inherited mode of response controlled by the nervous system.* This definition rules out all responses of organisms devoid of nervous tissue. Such responses are *tropisms.* It also rules out those responses in animals with nervous systems where the activity is initiated directly by chemical means, as, for example, the case in man where the presence of pancreatic juice in the intestines stimulates the glands there to pour forth their secretions. These cases are also tropisms. From such statements it should be clear that reflex action is not a state of consciousness but a mode of muscular and glandular activity. The part that is inherited is the synaptic connection or resistance which finally determines the nature of behavior. Figure 25 represents two reflex arcs. The motor neurones of one may be assumed to lead to the muscles that extend the hand and the other to lead to flexor muscles of the hand. The sensory neurone, which has synaptic connections with each motor neurone, comes from the skin, where it can be stimulated by a "painful" object. When such an object sets up a sensory nervous impulse, this impulse passes immediately out over the former of the two neurones by virtue of the relatively low resistance of this synapse, and the injurious object is dropped. It is this low resistance at the synapse which is inherited. Even in the extremely simple case that we have taken, however, the activity is not confined to one reflex arc. No one reflex arc acts independent of the other reflex arcs. In our present instance, before the hand could be opened (extended), the muscles which closed (flexed) it had to relax. In other words, the sensory impulse not only excited one group of muscles; it also inhibited the antagonistic group. Even the simplest activity therefore involves a co-ordination of reflex arcs. The mechanism of inhibiting muscle *F* is as much inherited as that for exciting muscle *E*. It is primarily for this reason that no sharp distinction can be drawn between reflex action and instinct. Other reasons we shall canvass later.

The reader should not infer from the preceding description that all reflexes occur through the spinal cord. The brain is particularly rich in reflex centers. Two important ones were noted in chapter ii, the medulla and the mid-brain.

Types of Reflexes.—It is customary to distinguish two main classes of reflex action, physiological reflexes and conscious reflexes. Consciousness never plays a guiding or determining rôle in reflex action. To the person who experiences the reflex, consciousness even seems to be an onlooker. It does, however, accompany many reflexes, the ones of the second class mentioned above. We are never directly conscious of the muscular contractions in physiological reflexes, i.e., we never feel the iris of the eye or the muscles of the heart contract. On the other hand we may be aware of the contraction of the muscles in sneezing, swallowing, or winking by attending to these activities. It should be noted that in the case of most conscious reflexes we are able to duplicate them voluntarily more or less accurately. We may wink or swallow voluntarily. It is important, however, to observe the fact that not only in this case is the performance more awkward and tiring, but it also has accompanying it a feeling of strain and effort (active participation) which is absent when the response is reflex. Physiological reflexes we are aware of only indirectly through their effects. We notice, for example, the clearing up of vision due to the focusing of the eyes (contractions of the iris and of the ciliary muscles which regulate the lens), or we may attend to the beating of the heart against the walls of the chest; but we are not conscious of the muscular actions themselves. Reflexes may also be classified as *conditioned* and *unconditioned* and as *allied* and *antagonistic*. The two former classes were discussed in the chapter on "Animal Psychology." Allied reflexes are those which occur simultaneously and facilitate each other. A dog starting to scratch, e.g., must shift his weight to three legs. The reflexes so involved are "allied" in

relation to the scratch reflex. Antagonistic reflexes are those which cannot occur simultaneously and which inhibit each other. Walking and running are two cases. The activities of paired flexor or extensor muscles form another example, i.e., one cannot extend his fingers at the same moment that he is grasping something with them. A clearer view of the subject can be gotten from a survey of the experimental work on this topic.

Typical Phenomena in Reflex Action.—Most of the experimental data that we have on the simpler reflexes come from a study of spinal animals. A spinal dog, e.g., is one whose spinal cord has been transected, or cut across, just below the medulla, thus freeing the reflex activities controlled by the cord from the influence of the brain. In animals like the dog the reflex functions of the cord persist unimpaired by the operation. In the dog the scratch reflex has been most thoroughly studied (Sherrington). If any point in the saddle-shaped area of the spinal dog shown in Fig. 33 is stimulated, the hind leg on that side is alternately flexed and extended in the typical scratch activity. Only allied harmonious reflexes are active at any one moment. The rhythm or rate of this reflex is constant (4.5 beats per second) no matter what the intensity of the stimulus. The scratch rhythm proceeds practically unmodified by variation of the rhythm of the stimulation of the skin. This partly depends on the fact that each reflex has a *refractory period* during which, even apart from fatigue, it cannot be fully re-excited. The refractory phase is very similar to inhibition and in the case of the scratch reflex depends upon changes in the central portion of the reflex arc. If the intensity of the stated stimulus is gradually increased, the phenomenon of *spread* occurs, i.e., more and more reflexes are aroused, due to the irradiation of the nervous impulses in the cord, until the whole dog is active. Furthermore, if two points of the saddle-shaped area are stimulated simultaneously, each stimulus by itself being too weak to

arouse a response, the reflex will nevertheless appear as a result of the summation of the nervous impulses. Other additional facts have been brought out that are of importance in securing a comprehensive view of the behavior mechanism. Each reflex, for instance, has a *latent time,* i.e., a period intervening between the application of the stimulus and the appearance of the response. The length of this latent time will vary from

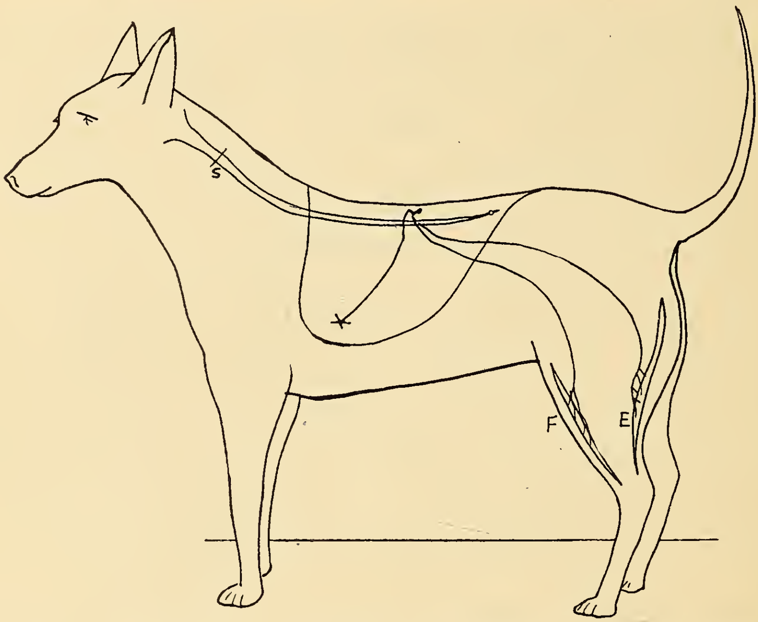

FIG. 33.—A spinal dog. The figure also indicates reflex arcs from the point x in the saddle-shaped area to the flexor (F) and extensor (E) muscles of the leg. The approximate location of the spinal section is shown in the cervical region (S).

.022 to .2 second, depending on the intensity of the stimulation. Sherrington has found that a reflex arc is just as ready to conduct, i.e., it responds as quickly, when it is inactive as when it is active at the moment of stimulation. *Fatigue* also influences reflex activity. Again, other things being equal, the protective reflexes—those aroused by injurious or noxious stimuli—have the right of way over other reflexes. At any

one moment, for example, contact with the floor tends to arouse the reflexes in the dog which give him his upright position. A painful stimulus breaking in upon this immediately gets control of the muscles of the leg and produces a protective reflex activity.

Resulting View of Behavior.—On the basis of these observations, how are we to describe the behavior of the dog or other animal at any one moment? Each animal has a definite limited number of muscles supplied by a limited number of motor nerves. All types of behavior, all forms of action, must use this single motor system. At any one moment eyes, ears, nose, and skin are sending sensory impulses in to the central nervous system. Here they must compete for the control of the motor system. Which impulse shall win out will depend upon the interrelation of the factors we have just mentioned: refractory period, spread, summation of stimuli, latent time, fatigue, inhibition and facilitation, and the "right of way." A slight variation in any one of these factors may be sufficient to give vision control of the muscles as opposed to audition. In this case the animal responds to what he sees as opposed to what he hears. This selection and determination of behavior are finally decided at the synapse on the basis of varying resistances to the passage of competing nervous impulses. This determination of behavior by synaptic connections we shall find exemplified in our present topic, "Instinct."

Definition of Instincts.—*An instinct is an inherited co-ordination of reflexes.* Like the term reflex, it refers not to a state of consciousness but to a mode of behavior. The two forms of inherited response shade into each other with complexity the chief difference. Popularly the term instinct—fear, anger, etc.—is applied to those particular inherited responses which are so well defined and prominent in the life of the individual as to attract attention. Many technical distinctions have been offered, none of which, however, have served

to differentiate completely the two modes of action. Consciousness, for example, cannot be made the point of difference, for it frequently accompanies reflex action, e.g., in the conscious reflexes we have discussed. The fact that instincts have "an end in view" has been given as the dividing principle, but we are equally as well aware of the purpose of winking as a defense measure as we are of that of the more complex behavior in anger. It is occasionally urged that instincts differ from reflex actions in that the former are accompanied by emotions while the latter are not. This criterion is inadequate because many instincts like play and food-getting have no emotions which invariably accompany them in the way that fear accompanies the instinct of flight and anger the instinct of pugnacity.

When we refer to instinct as an inherited co-ordination of reflexes, we are stressing the fact that what is inherited is the particular combination of reflexes. Anger in a man, if uncontrolled, involves the clenching of the fists, a threatening attitude, and changes in the facial muscles, in breathing, and in the heart-rate. If one strikes, that act is the stimulus for the next blow, and in this way a regular chain of activity is set up characteristic of the species. When we speak of the inherited co-ordination of reflexes in a bird, we may have in mind the following performance in nesting: The bird picks up a straw, flies to a limb, deposits it, and returns for another. This is repeated until several straws are accumulated, whereupon arrival at the nest causes the bird to execute certain turning movements by means of which the nest is shaped. The completion of the nest stimulates the egg-laying mechanism. The presence of eggs leads to brooding. In a similar manner we might trace other co-ordinations of reflex actions which are characteristic of birds of a given class.

In any particular case the only criteria for determining whether an act is an instinct or not are: (1) the relative perfection of the response on its first appearance, and (2) the uni-

versality of the response among members of the same species. These criteria enable us to pick out the instincts from such a list of activities as: typewriting, swimming, tennis-playing, nest-building, honeycomb-making, the killing of mice by kittens, the provisioning of the nest by wasps, the singing of birds, the pecking of chicks, etc. From this list we can at once discard typewriting and tennis-playing. Neither of these forms of response appears at the start full-grown, but each is built up by experience. Neither, moreover, is characteristic of all members of any species. With swimming we hesitate. Probably all people and all animals of certain species when in water over their depth execute certain characteristic swimming or floundering movements. To this extent we have an instinct—an inherited form of behavior. To the extent that the swimming is not perfect but is improved with practice we have not an instinct but a habit. Which of these terms we shall apply, instinct or habit, depends upon the relative amount contributed to the response by heredity and by experience. Many of the above responses are instinctive—nest-building, honeycomb-making, the pecking of chicks, etc. By this we do not mean that they are uninfluenced by experience or that they appear in unvarying form; we only mean that the inherited characteristic predominates. The following description of experimental data on instincts will serve further to clarify this point.

Some Experimental Studies of Instinct.—Practically all studies of instincts, in the popular sense of that term, have been made upon animals. (We should not forget, however, that breathing and circulation are instincts in the technical sense of that term and that these have been extensively studied in man.) There are two chief reasons for this: (1) animals are more readily controlled from birth and so make more convenient study material, and (2) man's responses are so deeply influenced by custom and habit that it is a rare instance when an instinctive response breaks through in anything like its original form and

vigor. This last fact is put to particular use in psychoanalysis, as we have already seen. In addition it has given rise to two contradictory statements. One is that man has more instincts than animals and that their interference is what gives the highly varied aspect to his behavior (James). The other is that man has no instincts in the true sense of the word (Thorndike). The former view is probably much nearer the truth.

1. *The Pecking of Chicks.*—A good example of this experimental work is the analysis of the pecking instinct in chicks, published in 1911 by Breed. He undertook the problem in order to determine from the study of a simple, easily controlled response how perfect a particular instinct is at its first appearance and just how much development takes place after the first performance. The pecking response (the terminology of Spalding and Morgan being followed) was divided into three parts: striking, seizing, and swallowing. The chicks were hatched in an incubator and then kept in a dark basket prior to the tests. By this method no opportunity was afforded the chick for practice outside of the tests. For the test the chick was placed upon a smooth black table-top upon which were a few grains of wheat. In pecking the chick might miss the grain; or strike it, but not seize it; or seize it, but not swallow it; or success might crown its efforts and the grain be swallowed. Fifty trials were given each day. Figure 34 shows how the chicks progressed from day to day. Curves 1, 2, 3 show the decrease in error with increase in age, while curve 4 shows the increase in perfection with age. We may thus see graphically that the chicks, starting out with only 15 per cent of the responses perfect, reached an average of 84 per cent. Not all of this remarkable increase in efficiency, however, is to be credited to practice or habit, as one might suppose at first thought. Undoubtedly as the chick grows older the nerve centers (synaptic connections) which control the instinct are maturing so that part of the increase in efficiency is due to the

growth of the instinct as a result of strictly inherited tendencies. This has been tested and proved the case by Shepard and Breed (1914). Figure 35 shows the results. Chicks were kept from pecking for various intervals, some for three days, some for

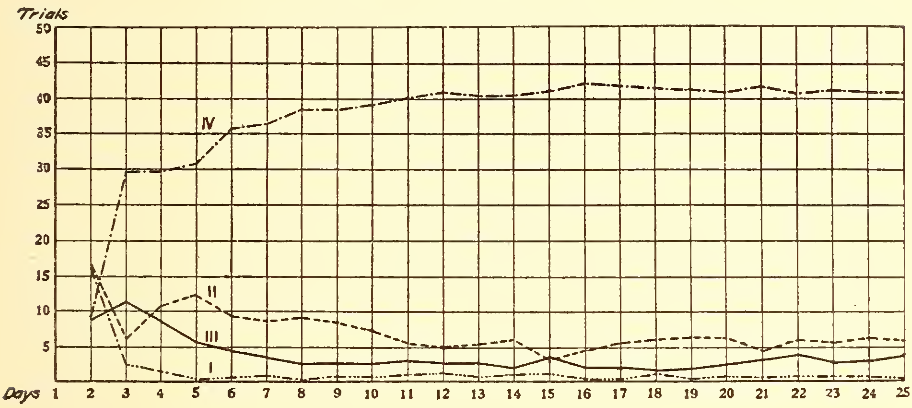

FIG. 34.—Graphic records of data secured by Breed in his study of the pecking instinct of chicks. The figure is described in the text.

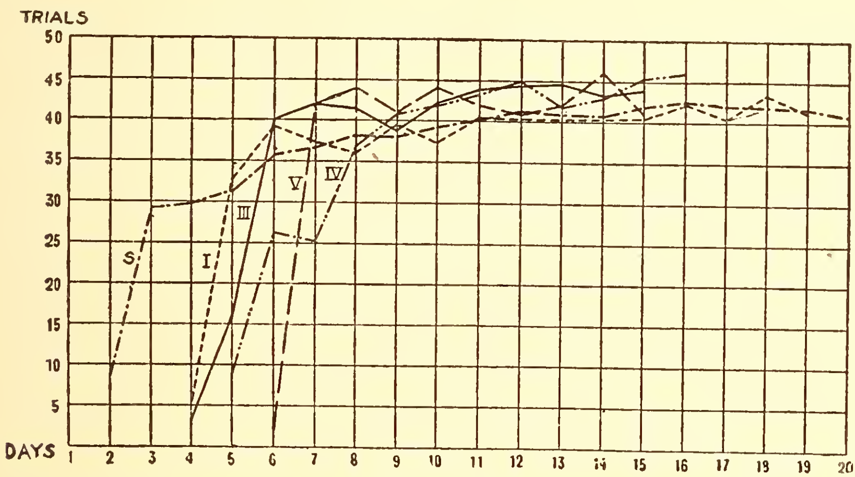

FIG. 35.—The development of the pecking instinct with normal conditions (*S*) and after delays of 3 days (I and III), after 4 days (IV), and after 5 days (V). *S* is based upon 21 chicks; I, upon 4; III, upon 6; IV, upon 3; and V, upon 1 (from Shepard and Breed).

four days, and some for five days, and were then tested. All chicks so delayed began below normal accuracy, but caught up to normal accuracy after two days' practice. This unusually rapid increase in accuracy during the first two days is made possible by the increased maturation of the nerve centers.[1] We have gone thus into detail in this experiment because, inadequate as it may be, it is one of the most accurate and quantitative studies that we have of instinct. This study and similar ones can tell us more than volume upon volume of speculation concerning the activities of animals.

2. *The Instinct for Vocalization in Birds.*—Studies by Yerkes and Bloomfield on the instinct to kill in kittens have indicated that certain inherited synaptic connections function independent of imitation and social example. In the following study by Conradi (1905), on the other hand, we find an equally certain case of instinctive activity and an equally certain influence of social forces (the stimulation of the bird by the songs of its associates) on the development of this activity. From this study and from that of Scott and Witchell it seems certain, moreover, that the call notes of birds are the primitive vocalizations, and are more uniformly inherited than the tendency to sing, which is present in addition in many birds. The tendency toward vocalization is inherited, but in what guise this tendency shall appear is determined largely by environment. This is illustrated by the fact ascertained by Scott that Baltimore orioles when kept alone and free from other birds developed a novel song of their own rather than the song characteristic of their species. Conradi's work illustrates the same point. He secured some young sparrows from the wild and placed them either under the care of a mother canary or in the room with canaries. Some developed the sparrow call note, and in addition all learned more or less thoroughly the

[1] This interpretative statement varies from that made by Shepard and Breed.

songs of the canaries with whom alone they all associated. I may quote one observation:

> On September 26, when the sparrow was a little over three months old, he was for the first time observed to give a trill. It was short and musical and was given a number of times in succession. These short trills were at first only rare but they increased in frequency during the year. When he gave them he would sit still on his perch and give them one after another very modestly. Now (Dec., 1904), he gives short trills interspersed with other notes, punctuating the whole by turning complete circles and semi-circles on his perch.
>
> None of these sparrows ever had the characteristic call note of the wild species, but by and by adopted those of the canary. They imitated the canary perfectly except that their voice did not have the musical finish.[1]

When removed from the canary environment they soon lost the canary song, but reacquired it on being again placed with those birds.

The Permanent Character of Instincts.—In spite of frequent opinions expressed to the contrary, there is no clear evidence that instincts in man and the higher animals are "intrinsically transitory"—to use James's term. Not all instincts are present at birth. Breathing, sucking, swallowing, fear (possibly), and others are, it is true; but many appear later, with the sex and parental instincts coming last. Once these forms of behavior have appeared, however, once the nerve centers which control them have matured, there is no good reason to believe that the organism ever loses them. Many instincts of infancy and childhood, such as sucking and playing, may be suppressed or transformed and hence be apparently absent in later life. In many cases, however, the behavior will appear upon representation of the proper stimulus, and in other cases the instinct will be found active as an integral part of some other form of behavior.

[1] E. Conradi. "Song and Call Notes of English Sparrows when Reared by Canaries," *Amer. Jour. Psych.*, XVI (1905), 197.

The Modification of Instincts.—Most if not all instincts are variable and not strictly rigid and mechanical. Probably none run their course in the same manner time after time. Much of this variability of inherited forms of behavior—which has been found even in the *Protozoa*—is due to internal physiological conditions of a temporary nature, i.e., fatigue, satiety, etc., which modify, or for the moment inhibit, all or part of the instinct. Variability, however, as found in those animals that profit by experience, is a matter also of permanent status. The basis of whatever variability there may be is to be found in the changed condition of the synapses controlling the final motor pathways to the muscles and glands. Inasmuch as instincts depend upon the proper functioning of total reflex arcs, the modification of instinct may occur either on the sensory (stimulus) side or on the motor (response) side, or on both. In each case the process is one of learning and habit-formation. Modification on the sensory side is illustrated by the fact that at one period of life I may fear "being on high places," while at a later period this stimulus no longer arouses fear. Or the situation may be the reverse. Objects that I do not fear at one period may come to arouse intense fear by virtue of my experience with them. On the motor side the instinct is modified by experience so that at one period of life anger, for example, is expressed in quite a different manner from that of its later form. The modification need not be, but often is, in the form of total inhibition of external movements. And in some individuals the "control" of instinct may be so thorough that no stimuli met in the ordinary course of events can call forth a visible disturbance like anger or fear, or even arouse internal disturbance that can be felt. Such a person may be termed "cold-blooded," "unsympathetic," and the like.

As the last statement implies, the facts of the last paragraph are of tremendous social and individual import. Because other peoples or classes do not respond to the same objects as we, we

ordinarily tend to deny that they possess the power to respond. The fact that a savage does not react with the instinct of shame at the absence of clothes does not mean that the instinct is lacking. As new customs arise, new stimuli take the place of the old in arousing instincts. Ribot and McDougall have well pointed out these facts. What arouses admiration or love in one class may arouse disgust in another. The whole process of educating (in the broad sense) and socializing an individual consists in determining for him, and in training him to accept, the approved stimuli for instinctive responses. With development the instinct may be set off by more and more subtle stimuli. (This is the same principle exemplified by the conditioned reflex of an earlier chapter, p. 16.) It does not take actual bodily injury to make one angry, for one may grow angry at an insult, at an attack on one's friend's honor, at a criticism of one's ideals. The ability to react to these more subtle stimuli makes one of the chief differences between man and animals and between man and man. The animal's instinct of anger and defense has only sensory stimuli, while man's instinct has in addition the stimulus of ideas representing the foregoing abstract relationships or values. Holt refers to this increasing abstractness as the "recession of the stimulus." The hope of a democratic social group lies in the ability of the majority to react to these less obvious stimuli as well as to the more obvious; that is, the average man must react with anger, if personal, national, or international ideals are threatened, as effectively, if not as readily, as when his bodily well-being is attacked by a visible opponent. One great function of a leader is to call the attention of his followers to the presence of such an "invisible" stimulus to the instincts.

The Origin of Instinct.—Theories as to the origin of instinct attempt to reconstruct the process by which in the past history of the race such co-ordinations of reflexes have appeared. When once all or part of the form of behavior has appeared in a given

animal, its transmission to subsequent generations is a question of heredity. As such it is a topic for *genetics* and is subject to the laws that govern the transmission of any structure. A connection of neurones, such as underlies fear or anger, is just as much a structure as is the color of the eyes, the existence of the nose, muscles, etc. Each individual inherits sense-organs and muscles which are essentially like those of his parents. Sense-organs and muscles are "pure lines," *homozygous characters*, and breed true. If an individual born with one eye (not as the result of accident, but of germinal variation) were crossed with another born with two eyes, the result would undoubtedly be similar to the case of inheritance of eye-color. Here, if parents have different eye-colors, the offspring of the first generation (F_1) all have a single color—called the dominant color. With respect to color they are hybrids. If these individuals interbreed, the next generation (F_2) will be some pure brown-eyed, i.e., the dominant trait, some mixed, and others pure recessive, i.e., blue-eyed. This form of inheritance is termed Mendelian. The union of the pure dominant or the pure recessive with a similar individual will result in pure progeny with respect to the trait in question. There is every reason to believe that if an animal should be found minus the instinct (structure in nervous system) of fear and could be crossed with an animal in whom the instinct was present, the progeny in the F_2 generation would show the typical Mendelian segregation as indicated above for eye-color. Yerkes has in fact performed tests of this type upon the inheritance of the instincts of savageness and wildness in rats, securing evidence for the foregoing type of inheritance.

Before an instinct so complex as fear can appear, certain sense-organs, muscles, and reflex arcs must already have appeared. The appearance of fear adds to this the structural fact of a certain kind of co-ordination. We have already seen that no distinction can be clearly drawn between reflexes and

instincts. There is no reason, therefore, to separate the question of the origin of one from that of the origin of the other. This, however, is just what the theories of the origin of instinct tend to do. When a receptor or an effector appears in the history of the race, it has a function. If this function (muscular contraction or glandular secretion) is controlled by the nervous system, the function is a reflex (or an instinct). The first appearance of any structure and the first appearance of any inheritable variations in it are both termed chance variations, or "sports." Those which are either useful or at least not particularly harmful survive and become permanent characteristics of the species (by the action of natural selection).

Historical Theories of the Origin of Instinct.—Three important theories for the origin of instinct have been proposed. (1) The *lapsed-intelligence theory* of Cope and Wundt holds that originally instinctive acts were performed consciously and voluntarily; that by repetition they became habitual; and that they were then inherited by the next generation as instincts. This theory is based on the assumption that acquired characteristics—habits, strength of arm, etc.—can be transmitted by heredity. General biological opinion, however, is against this belief. The theory would further lead us to assume a high grade of intelligence (consciousness) in lower animals, a supposition which is contrary to experimental fact. The error of the theory is a result of reading into animal life the known fact that in human experience acts performed consciously are later executed habitually and automatically. (2) The *reflex theory* of Spencer holds that the reflexes which make up a given instinct appear one by one, due to chance variations (sports), until the whole instinct is present. This supposition is in essential harmony with the point of view of the last section. The theory has been criticized because it is claimed that the individual reflexes are only valuable as parts of the whole, and by themselves cannot adjust the organism to its environment in such

a way as to aid in its survival. Why should a bird pick up straws or weave, it is asked, e.g., unless the whole nest-building instinct is present? The answer is clear. What appears first as a chance variation is the fundamental feature of nesting, staying near the eggs or actually hovering over them (Whitman). To this fundamental behavior other elements (digging a depression, collecting straws, etc.) are added by further chance variations. These additional variations may not be necessary for survival (witness the great variations in nest structure), but they may pave the way for, as well as follow after, more complex modes of life. (3) The *organic-selection theory* of Osborne, Baldwin, and Morgan attempts to remedy the supposed deficiences in the Spencer theory by combining it with certain aspects of the lapsed-intelligence theory. During the period of the imperfect and growing instinct the animal solves its problems partly by intelligence and accordingly survives. These intelligent variations are not inherited, but must be made anew by each generation. The point is important, but it hardly deserves to be ranked as a separate theory. It calls attention to the fact that habit-formation is a characteristic of all (most) animals and aids in survival, for there is no doubt that without it many or all species would perish. It does not, however, account for the appearance of an instinct in one group and not in another save by the assumption of unequal learning abilities. Each of the three theories, however, is important for our study because, by laying special emphasis upon different points, they aid us in getting a more comprehensive view of the whole question.

The Classification of Instincts.—Many classifications of instincts have been proposed, but we know too little as yet about the subject to formulate a very fruitful system. What is particularly needed is a thorough knowledge of the exact stimuli which set off the various instincts and of the exact effector activities involved. One of the best classifications is that sug-

gested by Marshall on the basis of function. Instincts which function for the preservation of the individual form the first class. Here belong fear, anger, food-getting, curiosity, walking, standing, etc. In the second class he places instincts which function for the preservation of the race. This would include sex and courtship instincts and the parental instinct. A third class includes instincts which function for the preservation of the social group. The most important ones are rivalry, constructiveness, acquisitiveness, and gregariousness. Until further extended rigorous experimental observation can make clear the detailed nature of the various instincts, we must be content with this brief mention of the problem of classification.

Instinct and Intelligence.—From our extended account of instinct, one must not conclude that it is a separate and distinct type of behavior. We have already seen its intimate relationship to reflex actions and are now to consider it in connection with intelligence. The popular mind assigns a preponderance of instinct to the animals and retains intelligence for man. If we use the term intelligence as synonymous with "thinking," that view is undoubtably correct. In the better sense of the term, however, we mean adaptive and variable behavior. To the extent that responses are determined by heredity, they are instincts; to the extent that they are modifiable within the animal's individual experience, they are intelligent. Instinct and intelligence, then, go hand in hand through the animal series. Myers has made the curious mistake of regarding instinct as the objective and intelligence as the subjective (conscious) side of behavior. This view, however, ignores the fact that modes of behavior differ genetically in that some are largely inherited and others are largely acquired. The terms instinct and intelligence are probably the best ones to designate this difference, although, as we have seen, no hard-and-fast line can be drawn to separate the two types of behavior.

Habit.—Habits as well as reflexes and instincts are modes of response and therefore are entitled to a place in the present chapter. *Habits are acquired co-ordinations of reflexes.* They differ from both reflexes and instincts in their acquired character, and in addition they are more complex than the former. An illustration will serve to make this clearer. Writing is a mode of muscular response which depends upon the proper adjustment and co-ordination of the reflexes of the hand and arm. Individuals do not develop this capacity for response without training, although the movements of the specific muscles appear early in childhood. Therefore writing cannot be an instinct, but is clearly a habit. Its elemental parts, as reflexes, are inherited; but the harmonious relationship of these, which is the essential characteristic of the response, is acquired. Contrast the situation with that of an instinct. Instincts, too, are composed of elemental reflexes, and inasmuch as they are modified by experience include phases that may be termed habits (intelligence). Yet however much fear or anger may be modified, the essential dominating characteristic of the mode of adjustment is still hereditary, and we term the response an instinct. The distinction between these two types of responses is a behavioristic, not a conscious, one. It makes no difference, as a rule, in the "feel," or consciousness, of a series of muscular responses whether they are essentially inherited or acquired. A sneeze would give rise to the same state of consciousness if it were a habit and not a reflex or instinct. We may point out, however, two ways in which consciousness may at times vary, depending upon the acquired or non-acquired character of the muscular and glandular activities underlying it. (1) Some instincts are more impulsive, more compelling, more irresistible, than any non-instincts ever are. No acquired response could approximate the impulsive character of a panicky fear or a blind rage. (2) Occasionally one finds a group or co-ordination of reflexes involving particularly the viscera (inner organs of the body)

where activity is invariably followed in consciousness by an experience termed emotion. Habits may enter in and modify these responses, but habits (acquired modes of response) never form the core of activity characteristic of the emotional seizure. A detailed account of emotions will be given in the following chapter.

The two problems of importance in the study of habit are: (1) What is the process of habit-formation and what are the laws governing it? (2) What are the nature and function of habit when its growth is completed? The latter problem we have discussed already, partly in the chapter on "Social Psychology" in connection with custom, and partly in the present account where the modification of instincts has been involved. The final summary of habit-formation must come in the chapter on "Memory," for the problem is one and the same with that of learning. To acquire a habit is to learn, and to learn is to memorize. When that topic is taken up it will be well, therefore, to reconstruct as well as one may the view of habit as an acquired co-ordination of reflex responses. For the present, however, we must turn our attention to the closely related topic of emotion.

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CHAPTER IV

THE EMOTIONS

Introduction.—With the study of emotions we come back to the question of states of consciousness. The close connection between instinct and emotions has already been implied in the terms that we used in the preceding chapter, for such terms as fear, anger, and love apply both to ways of acting and to ways of feeling. In both cases we are talking about unlearned processes. In each we have a fundamental, primitive, impulsive, and almost irresistible fact. Both tend to carry one out of the ordinary modes of response and feeling and beyond the pale of social restraint. Vigorous anger tempts one to throw caution to the winds, and the passions of intertribal hate reveal only too well the thinness of the veneer with which custom, tradition, and thought have covered over the original modes of behavior suited to an earlier habitat. The delineation of emotion in human life has always been the peculiar task of the poet and the narrator. It is to these, and to his own experience, that the reader must turn for the first-hand data on the emotions. Our own account in the present chapter will be analytical, not humanly descriptive. In defining emotion we may either analyze it into its elementary components (i.e., give a structural definition) or we may state its function. But one cannot say *what* an emotion is without plunging at once into the theories of emotion. Accordingly, we can best orient ourselves in the whole topic by considering critically the James-Lange theory or definition.

The James-Lange Theory of Emotion.—The conventional theory of emotion prior to 1884 when James[1] published his

[1] Lange wrote in 1885 and differs from James chiefly in considering the circulatory changes as the fundamental bodily disturbance in emotions.

account in the British periodical *Mind* was much the same as the lay notion of today. I see an object about to strike me; I am frightened and run. The running is an instinct which seems to express the emotion that precedes it. This older theory would insist that the neural basis of emotion is an excitement in the cerebral cortex aroused directly from the brain center connected with the sense-organ that has been stimulated. For James and Lange, however, I see the object, run, and then I am frightened. To quote James:

> Common sense says, we lose our fortune, are sorry and weep; we meet a bear, are frightened and run; we are insulted by a rival, are angry and strike. The hypothesis here to be defended says that this order of sequence is incorrect, that the one mental state is not immediately induced by the other, that the bodily manifestations must first be interposed between, and that the more rational statement is that we feel sorry because we cry, angry because we strike, afraid because we tremble, and not that we cry, strike, or tremble, because we are sorry, angry, or fearful, as the case may be. Without the bodily states following on the perception, the latter would be purely cognitive in form, pale, colorless, destitute of emotional warmth. We might then see the bear, and judge it best to run, receive the insult and deem it right to strike, but we should not actually *feel* afraid or angry.[1]

For James and Lange the consciousness of the organic disturbances *is* the emotion, " . . . . *the bodily changes follow directly the perception of the exciting fact, and . . . . our feeling of the same changes as they occur* IS *the emotion.*" Thus on the James-Lange theory the nervous impulse passes to the viscera and to the body muscles before reaching the brain as a condition of emotion. This problem of the neural basis of emotion we shall discuss in detail in a later paragraph.

This theory is exceedingly paradoxical, and it was made particularly so by the manner of its presentation. During the

[1] William James. *Principles of Psychology* (New York: 1890), II, 449–50.

years that immediately followed its publication bitter criticism was directed against it. To what extent one shall subscribe to the theory even now will depend upon how one understands it. There are two interpretations current: (1) The consciousness of the organic disturbances involved in instinct is the essential element in emotion, and serves to mark it off from other states of consciousness which are non-emotional. (2) Emotion is nothing but the consciousness of the organic disturbances involved in instinct. It is absolutely necessary to keep these two possibilities clearly in mind. The theory should be understood as James meant it, of course, and in an article published in 1894 he makes clear that he had in mind the first of the foregoing interpretations. Our first quotation above indicated this also, for there James is saying that unless the organic disturbances are present the experience (perception) is non-emotional and cold. It is not even essential to the James-Lange theory that one distinguish between one emotion and another on the basis of different organic accompaniments. It may well be that they serve to distinguish the emotion from the non-emotion, but not one emotion from another. Failure to hold these points clearly in mind has caused much confusion among the theory's critics.

Even a casual inspection of the various emotions of daily life offers much evidence in support of the theory. Anger, if it does not involve a general muscular tenseness, a tendency to attack, a rapid heart-beat, and an increased respiratory rate, is hardly anger. As James says, if we take anger or fear or any other emotion and mentally abstract from it all the bodily disturbances or organic resonances, no emotion is left. One may then see the offending object, perceive the dangerous situation, but fear not. It is to be understood that many, if not most, of the bodily activities which characterize emotions manifest themselves internally. The individual is specifically aware of few of these visceral changes, i.e., he does not notice,

perhaps, the heightened respiration, the change in the distribution of the blood, etc. Yet any or all of these bodily changes may change the whole quality of consciousness, just as we find to be the case in indigestion. Here one need not be specially aware of this, that, or the other bodily process, but he is vividly aware of general distress. From our last chapter we know that certain stimuli can arouse special muscular and glandular responses, due to synaptic connections set by heredity. If one is aware of the moving muscles, it is because sense-organs are located in or near them and are stimulated by the movement. The result is the passing of sensory impulses to the brain, and we become aware of the activity. We also know that to the extent the response is inherited, to that extent it is essentially uniform from one individual to another. The contraction of the pupil of the eye is the same in all people because the mechanism which controls it is the same. In a similar manner the fundamental quality of fear is the same in all persons, for underlying this sameness in the conscious states is a form of nervous activity which is alike in all individuals. Furthermore we must remember that the reflex action involved is complex, not simple. It is important that we bear these facts in mind in the following sections as we consider the criticisms waged against this view of the nature of emotion.

Criticism of the James-Lange Theory.—The consideration of the criticisms of this theory is a particularly valuable method of bringing out the various characteristics of emotional consciousness. We shall analyze these objections one by one. (1) It does not follow because an emotion cannot be imagined devoid of organic disturbances that the emotion is nothing but a consciousness of these changes. One cannot see color without extension or have a kingdom without a king; yet color is not extension, nor is a kingdom but a king. This criticism states the truth. Emotion *is* more than the consciousness of kinaesthetic, cutaneous, and organic sensations reflexly aroused.

It is also pleasant or unpleasant (affective characteristics) and includes as an essential part an awareness of some thought or object as the arouser of the emotion. However, this criticism is not applicable to James's own interpretation of his theory as we gave it above, for he insists only upon the organic disturbances as the essential element in emotion, not as the sole factor present. (2) If emotion is the consciousness of organic disturbances, how does it happen that the same emotion (fear) manifests itself differently in different individuals or in the same individual at different times? Some persons are paralyzed by fear, others scream, and still others run, or this variation in behavior may be true of one individual at different times. How can this be the same emotion with three such diverse types of organic disturbances manifested? The answer is clear and may take several forms: (*a*) Fear has not quite the same "feel" when one is paralyzed that it has when one can run or scream. To the extent that the bodily disturbances are different, to that extent the emotion is different (if the variation in bodily disturbances affects consciousness at all). (*b*) One must assume that if the different instances of fear have essentially the same feel or quality, it is because there is an inner core of organic disturbance which is common to all of the cases. (3) A different form of the same criticism is as follows: On the James-Lange theory how can one explain the fact that different emotions "express" themselves often in the same way? Some people cry in joy as well as in sorrow; others grow pale in fear and also in anger. All emotions, when intense, tend to have the same organic disturbances and such cases could be endlessly multiplied. The answer is, that where the emotional qualities really differ the variation must be due to a core of organic disturbance which varies with the different cases. In so far as the bodily disturbances are identical, to that extent the emotional experiences *feel* alike. There is no doubt that this is true in many intense emotions. Still the individual *knows*

whether he is deep in grief or in vengeful anger. This distinction, however, is here one of the meaning rather than of the qualitative content. The individual knows that the cause of his condition is the loss of a dear one and not an assault upon his integrity, or vice versa. Apparently in many cases the distinction between one emotion and another is of this type, while the emotion is an emotion and not a mere cognitive state only by virtue of its organic resonance. (4) How can the James-Lange theory account for an emotion's appearing before the organic disturbances are present and disappearing before they wane? I am walking along calmly when suddenly a dog rushes toward me. I am badly frightened before there are noticeable organic disturbances. I now see that the dog cannot possibly reach me. At once my fear is gone, although the bodily commotion may continue for some time. The explanation from the standpoint of the theory is twofold: (*a*) Certain fundamental internal organic changes may appear prior to external manifestations, and condition in this way the early appearance of the fear. These same internal changes may cease upon my seeing that the dog is harmless, with the result that my fear also vanishes. (*b*) A second answer is to deny that the fear has actually vanished until most of the bodily disturbances are gone. It may be a different kind of fear, but still it is a real fear. What actually occurs in many cases is that the fear gives place to another emotion, that of *relief*, which in its turn is accompanied by certain specific organic changes, i.e., certain variations in muscular tension, breathing, etc.

James held that the crucial test of his theory would come from an observation of patients totally anaesthetic. One of these cases he discusses at some length, that of Struempell's boy, who was totally anaesthetic save in one eye and one ear. Although nearly all incoming sensory impulses were thus cut off, the patient is said to have manifested grief and shame. James points out, however, that it is impossible to tell whether

he merely went through a few of the responses superficially connected with them or whether he actually experienced the emotion. Little can be hoped for from cases of this type, for unless the anaesthesia has been practically complete from birth, enough memory of previous experiences may be present to give the individual a faint but genuine experience of emotion.

Sherrington's Experiment with Dogs.—The English physiologist Sherrington has sought to secure crucial evidence of the foregoing type on the James-Lange theory by experiments on dogs. The animals used had their spinal cords transected just below the medulla, thus having most of the sensory impulses from the body cut off as far forward as the shoulders. Pleasure, fear, anger, and disgust were still clearly shown in the head and fore-limb segments of the animals. Other experiments were made where the Xth cranial nerves (the vagi) were sectioned, whereby the stomach, lungs, and heart were removed from having any possible effects upon consciousness; and yet emotional expressions were manifested. Still other tests were made upon puppies nine weeks old, in order to verify a possible objection to the other tests that the emotional expressions secured were due to the effects of experience. In these cases, too, clear traces of emotions were present. As a result of his work, Sherrington holds that organic processes cannot be the essential elements of emotional experience.

Two very significant objections are valid against these experiments, so far as they may be held to invalidate the James-Lange theory. (1) If the animals were conscious at all, no one knows how much of the "body" of their emotions vanished with the sectioning of the cord and nerves. The only fact that Sherrington has is that the movements in the anterior part of the animal were not changed in character or intensity by the operation. (2) There is no clear reason why the spinal animals should *not* have gone through certain instinctive reactions in their anterior segments. The nerves from the

eyes, ears, nose, mouth, diaphragm, and skin were still intact and sent impulses to the brain. The reflex arcs belonging to the fore-animal were still intact. The fact that the motor impulses could not reach the hind-animal and there result in muscular activity and in sensory impulses is no reason for inactivity in the fore-animal. It is doubtful if crucial evidence on the validity of the James-Lange theory can be secured by a method of this type. The introspective account is necessary before one can decide whether or not a given nerve injury changes the nature of the emotion.

Cannon on Bodily Disturbances in Pain, Fear, and Rage.— Between 1909 and 1915 W. B. Cannon, of the Harvard Physiological Laboratory, and his students published a series of papers chiefly concerned with the effects of pain, fear, and rage[1] upon the activities of the digestive tract and with the presence of secreted adrenin and its effect upon the body during these emotional states. His results are of interest in our consideration of the James-Lange theory. Cannon has shown conclusively that the normal contractions of the stomach and intestines are quickly inhibited by pain, fear, and rage. Not only is this condition true, but the salivary and gastric secretions are also checked.[2] This last point has been established by exposing a portion of the wall of the stomach through a permanent fistula and noting the changes in gastric secretion here incident to the foregoing instinctive responses. The changes in salivary flow (the dryness of the mouth in fear, e.g.,) are matters of common knowledge. Inhibition of peristalsis in the intestines was demonstrated by observing the animal, prior to, and again during, the excitement, with the Röntgen rays. Prior to the excitement peristalsis would be progressing

[1] This should not be interpreted as a case of consciousness affecting the body.

[2] This was shown by a long series of observers, notably Pawlow, prior to Cannon.

normally, only to stop when the pain, fear, or rage appeared. These facts will undoubtedly account for a large part of the "feeling of heaviness," lassitude, etc., incident to grief and anxiety.

The most interesting part of this work by Cannon, however, lies in the studies of the adrenal glands. These glands lie just anterior to the kidneys and are supplied by nerve fibers of the sympathetic system. They are ductless, pouring their secretion, adrenin, directly into the blood stream. Most of the data have been secured from cats by the use of careful surgical and physiological methods which space will not permit us to describe. Accordingly the following brief statements must represent for us the present status of our knowledge. The stimulation of an animal by pain or by the excitement in fear and rage is accompanied by the stimulation of the adrenal glands through the fibers of the sympathetic nervous system. The adrenin consequently thrown into the blood results in: (*a*) driving the blood from the viscera to the skeletal muscles where it increases muscular efficiency; (*b*) increased conversion of glycogen from the liver into blood sugar; (*c*) decrease in muscular fatigue; and (*d*) decrease in the time required for the coagulation of the blood. These changes are all in the direction of increased body efficiency. The increased blood sugar puts more fuel at the disposal of the skeletal muscles, whence it is driven through the action of the adrenin. In the case of wounds, which usually result from pain, fear, and rage, the blood clots rapidly. No essential variation in these facts was found for the three excitements studied. Unfortunately we have no experiments available for pleasurable, non-combative emotions, and consequently we are unable to say whether the above physiological changes do or do not occur in such cases.

These studies open up in a vital manner the field of visceral disturbances, where James felt sure the fundamental "cores" of particular emotions arose. Cannon, however, wrongly interprets

his facts as antagonistic to the James-Lange theory. On the contrary they support the theory strongly by indicating a very delicate and widespread bodily disturbance during emotional seizures. Their only negative value is that here are two emotions, fear and rage, which cannot be differentiated on the basis of the organic disturbances produced by adrenin. Further delicate investigations might discover a differentiating factor even here.

The Neural Basis of Emotion.—If we accept the James-Lange theory that the essential component of emotional seizures is the complex of kinaesthetic, cutaneous, and organic sensations aroused reflexly by the stimulus, our account of the neural basis of emotion must be as follows: A certain stimulus, e.g., visual, sets up a sensory impulse in the optic nerve which passes through the thalamus to the occipital lobe. Here associated centers are excited with the result in consciousness that we "perceive a dangerous object." The nervous impulses now discharge back into the thalamus, mid-brain, and spinal cord and out over the motor nerves to the effectors. The activities of these muscles and glands stimulate sense-organs in the skin, muscles, and viscera, whereupon sensory impulses pass to the thalamus and thence to the post-Rolandic area. The awareness of bodily commotion now appears in consciousness. This fused with the perception or apprehension of danger forms the major part of the emotion.

Recently Head and Holmes have contributed to our knowledge of the brain processes involved in emotion through their studies of patients with lesions in one half of the thalamus (unilateral thalamic lesions). When these lesions were in the anterior portion and consequently interrupted impulses from the thalamus to the cortex and vice versa, the following facts relative to emotions were noted on the side of the body affected: Irrespective of whether or not the body area to be studied was more or less sensitive than normal, pin prick, painful pressure,

extremes of heat and cold, visceral sensitivity, scraping, roughness, and vibration called forth on this area an excessive emotional response. The same was true for pleasurable stimuli, such as music. One patient, e.g., could not go to a concert because the affected part of her body became too excited! These results of Head and Holmes suggest very strongly that the essential brain center concerned in emotion is the thalamus, and that the influence of the cortex upon it is essentially one of control and inhibition.

Present Status of the James-Lange Theory.—The preceding pages have given in some detail the evidence for and against the James-Lange definition of emotion. In so far as the opposing evidence is theoretical, it can be convincingly answered; while the experimental facts so far available are not vital for the theory one way or the other. This evidence has its chief value in pointing out future lines of research, the source from which significant progress in the further understanding of emotion is most likely to come. In the present account emotion will stand as a state of consciousness whose essential characteristic is a core of certain organic, kinaesthetic, and cutaneous experiences instinctively aroused.

Principles Underlying Emotional Disturbances.—In his classical discussion of the *Expression of the Emotions* (1872), Darwin presents three principles which are to explain the origin of the different motor accompaniments of emotion. The first in importance is the principle of serviceably associated habits. Many of the instinctive responses in man, for example, are clearly reminiscent of the days when his ancestors fought with tooth and nail. The increased muscular contraction in anger which results in the organism's assuming a large and threatening aspect is obviously serviceable. We have seen how the secretion of adrenin aids the organism in mobilizing its energy quickly. And in a like manner we might enumerate the various reflexes and instincts which underlie the conscious experiences

called emotions, and in most cases (Darwin says "some") would be justified in assuming a "service" to the organism. The second of Darwin's principles is that of *antithesis*. The motor phenomena of this class are not, for Darwin, directly serviceable. He has in mind cases like the fawning of dogs and the affectionate behavior of cats. The principle is anthropomorphic and would be stated as follows: If a conscious state of one kind gave rise to a given motor disturbance, then the opposite conscious state would give rise to the opposite motor disturbance. Affection, therefore, in the dog leads to the opposite type of behavior from anger. This principle is obviously at variance with the James-Lange theory. Undoubtedly if two emotional states are different in quality or feel (it is difficult to think of them as opposite), they are so by virtue of the different instinctive reactions which underlie them, whose conscious accompaniments they are. The different motor disturbances depend upon inherited connections within the nervous system and not upon the moments of consciousness. The third principle is that of direct nervous discharge. We are here to think of diffuse nervous activity. The nervous impulses overflow into neighboring centers, and in this way produce by accident certain forms of behavior which in themselves are apparently useless. These instances of behavior may possibly form an exception to the first principle and are illustrated by such cases as trembling, profuse perspiration, urination, and diarrhea in fear. Not only do these responses seem to have no real purpose; they may be positively disadvantageous to the organism in its adjustment to the environment. These three principles of Darwin's may be regarded as supplemental to the account of the origin of instinct presented in the foregoing chapter.

Classification of Emotions.—Numerous classifications of the emotions have been proposed, each of which is based upon some one characteristic of emotional complexes and is at least valuable for calling our attention to that particular feature of the experi-

ence. Thus we have emotions grouped as pleasant or unpleasant; as sudden, gradual, or intermittent in mode of appearance; as depressing (asthenic) or invigorating (sthenic); as social or non-social; as immediate, retrospective, or prospective; and as simple or complex. Of these we shall discuss only the last two.

Thomas Brown suggested the classification on the basis of temporal reference. In the *immediate* emotions there is no reference to time. Here belong such experiences as admiration, cheerfulness, melancholy, love, sympathy, pride, humility, wonder, and beauty. In the *retrospective* emotions reference is to some object as past, such as one finds in anger, regret, remorse, sorrow, and gratitude. *Prospective* emotions arise from situations referred to the future, such as occur in the emotions of hope, fear, worry, and desire.

What is perhaps the most fundamental and thoroughgoing principle of classification is that of *complexity*. Certain emotions like fear and anger are primary and irreducible—they cannot be analyzed into component emotional parts. Others like admiration, envy, and sorrow can by introspection be analyzed into other simpler emotions. Conspicuous advocates of this system of classification are Bain, Ribot, and McDougall. The principle, moreover, may be interpreted genetically as well as analytically, for there is always the tendency to regard the simple, primary emotions as the first to appear in the life either of the race or of the individual. It is difficult, however, to determine the amount of truth in such an interpretation, though undoubtedly it can be relied upon to a large degree.

Simple and Complex Emotions.—Fear, anger, and love (the tender emotion) are the emotions which Bain, Ribot, and McDougall agree are the simple ones, although, as we shall see, the latter two authors would include still others. By the tender emotions we are to understand something different from sex gratification and from the experience of love as that term is

usually applied. Love, we shall see, is a sentiment. The tender emotion is akin to sympathy and the parental feelings. It is a massive, pleasurable experience whose characteristic physical accompaniment is contact or the embrace. It is in this form that it occurs in very small children, and it is this form which is essentially maintained throughout life, although it may become abbreviated to a mere friendly slap on the back. McDougall finds its fundamental (instinctive) basis in the parental instinct. The stimuli which arouse it most readily are: helplessness or misfortune in a member of the same species; absence of bodily contact and warmth (particularly in children); and situations where gratitude is called forth. It is essentially a social emotion.

Fear is intimately correlated with the instinct of flight. Its stimulus in adults is any threat too great to be resisted successfully. Other things being equal, where this meaning (the overwhelming threat) attaches to an object the emotion appears in the individual against whom the threat is directed. Opposed to this general stimulus, which may be highly elaborated by experience, is that of the original stimuli to fear. Here we should probably class all intense stimuli—noises, lights, etc.—solitude, and strange surroundings. As a further stimulus Thorndike adds "being suddenly brushed or clutched" in the dark. It is perhaps the first emotion to appear in infancy, unless "satisfaction" at food and contact precedes. Ribot would trace in the individual a gradual development of fear, as well as of other emotions, from the crude instinctive fear to the specialized fears aroused as a result of personal experience with various objects.

Anger is correlated with the instinct of pugnacity. Its stimulus in adults is any threat or obstruction which is not too great to be resisted. Fear and anger are fundamental for preservation. Anger probably appears later in infancy than fear and the tender emotion. According to Ribot it passes through three stages of development: first, the sheer animal

attack (with intent to destroy); second, a simulated aggression in which no actual attack occurs; and third, a still more deferred type which appears in the form of envy, resentment, etc.

To these three primary emotions of fear, anger, and the tender emotion Ribot would add pride, humility, and the sexual emotion (excitement). McDougall in his list would include disgust, wonder, sexual emotion, and positive (pride) and negative (humility) self-feeling.[1] We may accept McDougall's list with the possible exception of disgust, into which an element of fear seems to enter and which is therefore complex.

All emotions other than these primary ones are complex. They are resolvable into elements which are themselves faint arousals of the primary emotions. No account of an emotional experience is, of course, complete which stops with the listing of its component emotions, for the description must involve the points brought out in the foregoing systems of classification as well as an enumeration of the essential stimuli and organic responses. We want to know whether the emotion is sthenic or asthenic, prospective, retrospective, or immediate, etc., as well as whether it is simple or complex, and if it is complex what its components are. McDougall has made one of the best analyses of complex emotions into simple ones. The following quotation will indicate the type of method and results as well as the defects naturally involved in any description from a single angle of so complex a thing as a moment of consciousness:

> There is another group of complex emotions of which anger and fear are the most prominent constituents. When an object excites our disgust, and at the same time our anger, the emotion we experience is *scorn*. The two impulses are apt to be very clearly expressed, the shrinking and aversion of disgust, and the impulse of anger to attack, to strike, and to destroy its object. This emotion is most commonly evoked by the actions of other men, by mean cruelty or

[1] It is interesting to note that pride and humility are given a prominent place by British psychologists as early as Hume.

underhanded opposition to our efforts; it is therefore one from which original moral judgments often spring. It is, I think, very apt to be complicated by positive self-feeling—we feel ourselves magnified by the presence of the moral weakness or littleness of the other, just as on a lower plane the physical weakness or smallness of those about one excites this positive self-feeling, with its tendency to expand the chest, throw up the head, and strut in easy confidence. The name "scorn" is often applied to an affective state of which this emotion is an element; but, if this element is dominant, the emotion is that we experience when we are said to despise another, and its name is *contempt*, the substantive corresponding to the verb despise; scorn, then, is a binary compound of anger and disgust, or a tertiary compound if positive self-feeling is added to these; while contempt is a binary compound of disgust and positive self-feeling, differing from scorn in the absence of the element of anger.[1]

Aesthetic Emotions and Empathy.—The aesthetic emotion, or the enjoyment of the beautiful, is another complex emotion of particular interest, not only because of its social interest and value, but also because of a supposedly peculiar characteristic of *empathy* (Titchener's term) which it possesses. As an emotion aesthetic enjoyment is pleasurable, stable, of relatively low intensity; its component parts usually succeed each other slowly with a minimum of antagonism; and, finally, it is essentially relaxing and contemplative rather than exciting and predisposing toward practical activity. It is aroused by a great variety of stimuli which are consequently termed "beautiful objects." The essential characteristics of these stimuli for the adult members of European culture we know in general. The stimuli, if auditory, must obey certain rules of melody, rhythm, harmony, and unity. If they are visual—as in painting and the plastic arts—they must obey certain rules of proportion, grouping, and design. The characteristics of the stimuli for the aesthetic emotion are not absolute, however, and the secret

[1] William McDougall. *Introduction to Social Psychology* (Boston: 1912), pp. 135–36.

of artistic genius is its ability to create its own rules and find out new and subtle ways of arousing the emotion.

Lipps gave the name *Einfühlung* (*empathy*) to the ascription of our feelings to the external object. A Doric column gives one the impression of balance and of lifting that which it supports. The "balance" and "lifting" are essentially muscular attitudes of the observer which are attributed to the column. In a similar manner one tends to imitate or mimic the attitudes, gestures, and expressions of the figures in sculpture and painting. By so doing he "enters into them." When one calls the day gloomy or sad, it is an instance of empathy, or, as Ruskin here terms it, of "the pathetic fallacy."[1] Stated in this manner, as the fusion of our emotional and subjective life with the external object, the principle and fact seem unusual. If we remember, however, that the "external object" is a visual or auditory perception, empathy no longer appears strange. "Unpleasant pain" and "exciting heart-beat" are also clearly instances of empathy, although here the "object" is a sensation located within the body. In art empathy is a case of fusion of the clear and analyzed (vision and hearing) with the obscure and unanalyzed, kinaesthetic-organic experiences. Outside the realm of art it is commonly known that two odors will fuse together, and that the muscular sensations from gagging will fuse with tastes and odors to constitute the experience of nausea. Artistic empathy is but a case of bodily disturbances (kinaesthetic, organic, and cutaneous sensations) fusing with visual and auditory sensations. These latter two are the aesthetic senses (i.e., their stimuli include the "beautiful objects") largely because they can fuse in this manner with organic sensations and still preserve their individuality. Taste, smell, and touch on the other hand do not offer beautiful objects, and they do melt in with the consciousness of organic disturbances.

[1] In this form it is not far removed from the ontological argument of philosophy.

Accordingly, they do not retain their individual character. Viewed from this angle, we may consider empathy as one of the fundamental facts of emotional life.

Mood and Temperament.—Moods and temperaments are not emotions. They represent more or less permanent predispositions, or tendencies, to experience emotions of a certain type. An individual may be in a gloomy or a joyous mood, an angry or a fearful mood. These moods are of relatively brief duration, and they indicate that the person is particularly susceptible to depressing emotions or to pleasant ones, to combative or to fearful ones. By "predisposition" we mean that synaptic connections in the individual are so affected as to make probable the appearance of these types of emotions. The predisposition may be set up by indigestion, poor sleep, good or bad news, etc. A person whose mood is particularly inconstant is "one of moods." The conscious states of the normal individual, however, are usually joyously toned.

By temperament we refer to emotional predispositions that are probably innate and that probably vary but little during large periods of the individual's life. Historical usage has recognized four: the *sanguine*, the *ardent* (*choleric*), the *nervous*, and the *phlegmatic*. The sanguine are characterized as people of optimistic outlook, of ready but shallow emotional response. The ardent and the nervous are much alike, being individuals who are excitable, and whose emotions succeed each other rapidly and with more than medium intensity. They are the reformers and prophets. With the phlegmatic, on the other hand, emotions move slowly, are aroused with difficulty, and probably tend to be unpleasantly toned. The melancholic is also a temperament well recognized. Here depressive emotions tend to prevail, appearing strong and massive in character, and moving slowly.

Sentiment.—Sentiment is another term that we frequently hear in a layman's discussion of emotional experiences. Popularly it refers to any mild emotion and is often applied particu-

larly to a shallow form of the tender emotion. Shand, however, has given it a valuable technical significance. He has recognized that in addition to primary emotions and to their derived complex emotions there exist organized systems of emotions centered upon certain objects. This organized system of emotions is termed *sentiment*. The recognition of this fact takes us away from an atomic view of consciousness and behavior, and brings us face to face with the fundamental fact of continuity and integration. Anger, fear, joy, and sorrow are innately connected with each other in such a way that the "frustration of anger provokes a bitter sorrow, its satisfaction a peculiar joy of elation, obstruction to it, increase of anger, and the threatened loss of the sweets of revenge, when anger is deliberate and develops hate, may even excite fear."[1] A similar account could be written of fear, joy, and sorrow.

Of the sentiments, love and hate are the chief in importance. To love a person (stimulus) is not to experience the tender emotion or the sex emotion constantly, or even to experience these alone. I may truly hate or love a person and yet not think of him during great intervals of time. An individual loved is above all an object vitally associated with all of the primary emotions, a stimulus at one time of fear, anger, sorrow. Chaucer has well described it in an oft-quoted passage from the "Romaunt of the Rose":[2]

> Love it is an hatefull pees,
> A free acquitaunce without relees,
> A truthe frette full of falsheede;
> A silkenesse all sette in drede,
> In hertis a dispeiryng hope,
> And full of hope it is wan hope,
> Wise woodnesse, and wode resoun,
> A swete perell in to drowne,
>
> . . . . . .
>
> Also a swete helle it is
> And a soroufull paradys, ...

[1] Alex. Shand. *Foundations of Character* (London: 1914), p. 37.
[2] Ll. 4703 ff.

If the loved object prospers, I am joyous; if it is threatened, I fear or am angry; if it is injured, I sorrow and grieve. It is the center of a system of emotions. To speak of a system is to refer to an association between emotions or, better, between their physical correlates, instincts. This association is apparently inherited. We may therefore speak quite properly of an inherited co-ordination of instincts, the conscious side of which is the sentiment. A similar account could be given of hate, of parental affection, of ambition, etc. Emotions as they become vital factors in conduct and character enter into the type of systems or associations which we have described.

The Function of Emotions.—A part of the function often assigned to emotions has been given to instinct in the preceding chapter. Emotions give warmth and value to the series of conscious states. Through empathy this personal phase is transferred to impersonal objects, and "Nature" takes on an "interesting" light. Without emotions the stream of consciousness would be "coldly" intellectual. This condition is occasionally remotely approached by apathetic or severely intellectual persons.

To say that emotions aid in memory, affect attention, and help in the adjustment of the organism to its environment is practically true. The memory of emotionally vivid experiences is exceptionally good, for attention in such instances is highly concentrated and absorbed by the excitement, a situation that facilitates good retention. Emotion does occur during critical moments of adjustment, but to assert that it actively functions in any of these adjustments is to assign a causal connection of mind and matter which cannot be justified. Emotion occurs parallel with, or subsequent to, the nervous activities which condition empathy, memory, attention, and adjustment in general. Such a statement, however, takes from emotional experience neither one jot nor one tittle of its intense human value.

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CHAPTER V

THE AFFECTIVE PROCESSES

Introduction.—From a study of the emotions we pass naturally to an analysis of affection, or the affective processes. Reference has already been made to the characteristics of *pleasantness and unpleasantness* which attach to many emotions. These are the two affective processes upon whose existence psychologists agree. There is no chapter in modern psychology in which less is definitely known than here—and yet pleasantness and unpleasantness are conscious states of admittedly great importance. It is extremely difficult to observe them minutely, and in this respect their study may take rank along with the most difficult problems of observation and description in biology. Even when we approach them from the standpoint of their correlated bodily changes the study is quite as baffling and the facts just as elusive as from the side of the conscious processes.

On the side of the behavior of the organism, pleasure is intimately connected with reactions of approach to, and unpleasantness with reactions of retreat from, the stimulus. The conscious state of pleasantness, furthermore, seems to be aroused especially during moments favorable to the organism, and unpleasantness during unfavorable moments. It is largely for this reason that some writers have claimed that even animals as low in the scale as the amoeba and paramecium have a vague consciousness of pleasantness and unpleasantness correlated with their positive and negative responses. We have already seen, however, that the ascription of consciousness to such simple organisms is extremely precarious. When we know exactly what bodily conditions underlie these conscious states in man, we shall be

in a better position to decide concerning the validity of such an inference.

The affective processes differ from emotions pre-eminently in their lesser intensity. Pleasantness and unpleasantness never reach the degree of excitement attained in fear, anger, and jealousy. Most psychologists believe that the affective processes are also less complex than the emotions. It is not clear, however, that they are less complex than mild fear, anger, or joy. From the standpoint of how the experiences feel, pleasantness is not unlike mild joy, and unpleasantness is not markedly unlike a subtle anger. Furthermore the two affective experiences, as they increase in intensity, pass over readily into the two emotional experiences. In addition to this similarity to emotions, psychologists are agreed that there is a very great similarity between the feel of affective processes and the feel of organic and cutaneous experiences such as tickle, lust, and pain. By most psychologists, however, pleasantness and unpleasantness are regarded (perhaps incorrectly) as irreducible conscious states different from sensation. All conscious states would then be resolvable into these two mental elements—sensations and affections. For the present we shall confine our attention to a description of the affective processes, leaving the nature of sensation for discussion in the following two chapters.

Attributes of Affective Processes.—We can best secure an introduction to the nature of the affective processes through a consideration of their essential attributes. Each affective state possesses in some degree the attributes of intensity, duration, quality, clearness, location, and meaning. There is agreement among psychologists upon the first three of these attributes. The only dispute is over the number of qualities. Ordinarily it is said that there are two irreducible qualities, pleasantness and unpleasantness. Wundt, however, declares for six qualities: strain, relaxation, excitement, calm, pleasantness, and unpleasantness. There is no doubt that such conscious states

exist and do play a prominent rôle in daily life. The question is whether they are all irreducible, unanalyzable, elemental. It is pretty generally agreed that strain and relaxation are combinations of kinaesthetic and organic experiences coming from the muscles and viscera. The same statement is applicable to the awareness of excitement and calm, although these are more difficult to analyze. Pleasantness and unpleasantness are the most difficult of all to analyze, yet many psychologists regard these, too, as combinations of sensory processes. Wundt's hypothesis of three pairs of affective qualities has the great merit of recognizing the complexity of affective experiences, for it seems more plausible that our feelings, other than those that are obviously emotions, are composed of combinations of six qualities rather than of only two. His position is an increasingly important one when attention is called to the antagonistic character of the members of each of the three pairs. The affective qualities of pleasantness and unpleasantness are mutually exclusive. They cannot coexist in consciousness. This is also true of strain and relaxation and of excitement and calm. Moreover, Wundt's point of view recognizes affective experiences that are at the same time relaxing, calm, and pleasant, or that consist of any other combination of three qualities where no two are opposites. Each affective quality may decrease to zero, then giving place to its opposite, as a pleasantness may grow less and finally give place to an increasing unpleasantness. In the last few sentences we have been commenting upon an attribute supposed to be peculiar to affection, viz., the *antagonistic character* of the elements in the pairs of affective qualities. We shall come back to this problem in the following section.

Let us return to the list of attributes given above. When psychologists insist that the affective processes lack clearness, they mean that these processes lack *focal* clearness. In other words, they cannot be attended to directly. If a person is eating

sweet candy and if the experience is pleasant, he nevertheless cannot put his mental finger, so to speak, upon the affective process. If he attempts to bring the pleasantness into the focus of attention he will find that he brings in the sensation of sweetness, of contact, or of temperature, but that always the pleasantness itself evades him so that he never can say, "Here, I have it!" Many psychologists insist, however, that an affective process can be brought into the focus of attention. In whatever way skilled observers may finally settle the question, it is certain that even though affective processes may not enter the area of maximal clearness, they must, so far as they are conscious states, be clear in some degree.

Location is another disputed attribute. Can an experience of pleasantness be located at some part of the body, or is it an experience that pervades the entire organism? Can the pleasantness of the taste of candy be localized in the mouth, or is it only the taste and contact that are there? Here again answers differ. The question, however, formulated in this manner, is not so much a question of whether the affective process is localized as it is a question of how definitely it can be localized. One cannot definitely localize a pure tone or a faint odor. What one does is to locate them, now here, now there, but always in external space. Similarly the affective processes are at least localized within the body—save in the cases of empathy discussed in the preceding chapter. When the localization is within the body, individuals obviously differ greatly in the definiteness and accuracy with which the localization can be accomplished. To one it may seem that the pleasantness of music is located in the facial muscles and in the chest. To another such a statement seems absurd, for to him the pleasure may pervade his entire body. However, in either case localization of a kind is present.

Meaning is an attribute ordinarily assigned to sensations and images. Inasmuch, however, as the neural processes which

underlie affective processes must be related to other neural processes, meaning on the conscious side must be attached to affective qualities. Observation verifies this. At one moment pleasantness may mean food; at another, rest; and again, the approach of sleep. We may unhesitatingly say that whenever an affective quality appears in consciousness as a concrete actual experience, it has some significance. This significance is its meaning.

Aside from the general attributes which have just been discussed, the individual charactersitics that are peculiar to affective processes, or that are often said to be peculiar, may best be considered by comparing affection and sensation.

Affection and Sensation.—By sensation we are to understand such things as the consciousness or awareness of red, green, and purple in vision, and of noise and tone in audition. Sensation involves the activity of a specific segment of the nervous system extending from the sense-organ to the cortical center. Affection, on the other hand, is said to depend not on the activity of a specific segment of the nervous system but upon the mode of functioning of the nervous system as a whole. The evidence upon which such a statement rests is as follows: (1) The affective qualities may accompany any sensory activity, visual, auditory, cutaneous, etc. Furthermore there are no sense-organs peculiar to pleasantness and unpleasantness as the eye is peculiar to vision and the ear to hearing. (2) Affective qualities are diffused throughout the organism and cannot be localized definitely within it, a condition which would indicate a dependence upon widely spread nervous activity. With regard to the second point just given, we have already called attention to the fact that the ability to localize accurately within the body is maintained by various observers. It should also be noted, moreover, that many sensations and combinations of sensations diffuse throughout the body. A feeling of warmth or chilliness spreads over the entire organism; colicky pains are

voluminous; and the general sensory complexes termed "feelings of malaise" and "feelings of vigor and bodily well-being" are diffused throughout the entire body. The localization which they possess is merely a reference to the body as opposed to the external world. It is therefore clear that this second bit of evidence fails to separate affection and sensation. With respect to the first bit—that pleasantness and unpleasantness are not correlated with a specific sense-organ—it may well be pointed out that neither is emotion so correlated. Fear, anger, scorn, etc., may be aroused by objects affecting the ear, eye, tongue, nose, or any other sense-organ. Yet we saw in the last chapter that the essential element in emotion is the consciousness of organic, kinaesthetic, and cutaneous sensations. So far as the evidence goes, affective processes may well be essentially the consciousness of a fusion of the same kind of sensory processes. Wundt's addition of strain-relaxation and excitement-calm to the affective dimensions is supporting evidence, for, while Wundt does not so interpret it, other psychologists insist that the qualities that he adds are combinations of sensations. Yet the only difference between the three pairs is one of ease of analysis into elements. If affective processes are not essentially sensation fusions, their neural basis must be an activity originating in the cortex (centrally aroused brain activity) as opposed to an activity originating in a receptor (peripherally aroused brain activity).

A little later in this chapter we shall consider the bodily disturbances accompanying the affective processes. To the extent that definite bodily processes can be found, to that extent are we able to construct the probable neural basis. These bodily disturbances come to consciousness as fusions of sensations. Titchener has advanced the speculation that relatively simple undeveloped receptors in the viscera may be the origin of the neural activity underlying affection. Such a view implies the sensory quality of affection because it specifies that the

neural acitivity originates in the periphery, i.e., in the receptors. (Titchener, however, regards affection and sensation as two distinct mental elements.)

Psychologists have also suggested that sensation and affection differ in that the former is objective and the latter subjective.[1] But emotions are subjective and so are the sensation complexes of "malaise" and "well-being" above mentioned. Whether a given state of consciousness is called objective or subjective depends upon its localization inside or outside the body and upon its extent or diffusion. This attempted differentiation of sensation and affection sometimes proceeds along another line. Sensations are said by Angell to give us the *what* of experience while affections give us the *how*. A sensation tells us that the object is red, or middle C (in music), or hot. The affective process on the other hand tells us how these qualities affect us, pleasantly or unpleasantly, etc. But the *how* may become the *what*, paradoxical as it may sound. If what I wish to know is *how* a given quality affects me, if *what* I want to know is the affective content of consciousness, then the above paradox is accomplished. Perhaps usually the affective processes are the dominantly subjective side of consciousness, and perhaps they are usually the *how* of our attitude toward objects. They are not, therefore, conscious states which differ from sensations as one element from another. Fear and anger are also "how" aspects of experience; yet they are essentially sensory fusions. Kinaesthetic, organic, and cutaneous sensations go to make up the consciousness of our body as present, and in this manner they naturally form the background upon which external, objective states of consciousness are projected. This is a further reason why the affective processes are so inti-

[1] The term subjective is not used here to refer to the illusory and hallucinatory aspects of experience. One may fancy he hears his name called and still localize the call outside his body, and in this sense regard it as objective.

mately connected with the feeling of self or personality. Accordingly, to know what affects a person pleasantly, unpleasantly, excitingly, or calmly, with strain, or relaxation, is to know the innermost secrets of his nature.

In the preceding section we took up the question of the antagonism of the members of each pair of affective qualities. Pleasantness is antagonistic to unpleasantness because it cannot coexist with it, that is, a person is either pleased or displeased. These two conscious qualities may alternate with great rapidity, but they cannot be in consciousness at the same time. The same thing is true of strain-relaxation and of excitement-calm. This attribute of mutual exclusiveness is held by certain psychologists to be peculiar to affective processes. But many sensations cannot coexist. They either cancel each other or fuse into a new experience that cannot well be analyzed. Two tones of the same pitch sounded on the same type of instrument do not continue to exist as separate tones but fuse into a single tonal experience. Two odors will not coexist in consciousness. Either they will alternate rapidly (rivalry), or they will fuse to make a new and unanalyzed odor, or they will cancel (compensate) each other, leaving no odor at all. Organic sensations are further notable cases of fusion, of inability to exist simultaneously in consciousness. This attribute is, therefore, clearly not peculiar to affective processes.

The net result of our inquiry here, therefore, is that affective processes are quite probably not separate mental elements, but are fusions of organic, kinaesthetic, and cutaneous sensory processes. Because the problem of adjusting ourselves to our environment is the dominant one, the focus of consciousness, i.e., the place of the clearly analyzed experiences, is most often filled with visual and auditory data. Only in the neurotic and neurasthenic do the kinaesthetic, organic, and cutaneous sensations dominate the focus during considerable intervals of time. We may therefore think of consciousness

as dominated usually by "intellectual" rather than by "feeling" experiences.

Stimuli for Affective Processes.—Under the heading of stimuli we must consider those internal and external conditions whose presence is normally followed by one or another of the affective qualities. Most of our information bears upon the qualities of pleasantness and unpleasantness.

Unpleasantness is usually excited by the sensation of pain, by sensations and ideas of great intensity or of great duration. Stimuli which occur suddenly and accordingly command involuntary attention are perhaps usually unpleasant. (Of course, where *objects* are referred to as pleasant, unpleasant, exciting, etc., we are dealing with cases of empathy, of fusions of the internal with the external processes. We do not mean that pleasantness is a characteristic of the object as its color is.) Historically great emphasis has been laid upon the fact that whatever thwarts our purpose or the ongoing activity of the moment is unpleasant. This explanation received its first important treatment from Herbart. If one is engaged in the study of a mathematical problem, whatever appears in consciousness unrelated to the solution is unpleasant. Likewise, if one is walking and a break in the path interferes with the ongoing automatism, unpleasantness usually appears in consciousness. It is interesting to note, in connection with our discussion of emotion in the preceding chapter, that the thwarting of purposes is one of the customary stimuli for anger. Whether the feeling reaction shall appear as anger or as unpleasantness depends upon the intensity and significance of the interference. Closely related to the conditions of unpleasantness which have just been mentioned is this fact: any using up of more energy than the sense-organ or muscle ordinarily has access to is usually unpleasant. Thus a too prolonged stimulation or a too intense stimulation, a too prolonged or a too intense muscular exertion, is unpleasant.

To a certain extent pleasure is excited by the opposite type of stimulus from that which arouses unpleasantness. Stimuli which arouse activities within the normal capacities of the receptors and effectors are ordinarily pleasant. The objects, however, must not be of too brief duration or of too slight intensity, for, if they are, the difficulty of attending to them results in unpleasantness. Those objects (sensations) which usually favor or aid our purposes and ongoing activities are pleasant. Accordingly ease as opposed to difficulty of attention is pleasant. Again, it is interesting to note that the objects and relations which produce pleasure also produce joy when their intensity or significance is greater.

Stimuli from Art.—So far no mention has been made of the great class of beautiful and ugly objects, aesthetic and unaesthetic stimuli, that arouse pleasantness and unpleasantness. Since to outline carefully the characteristics of these objects is to write a treatise on aesthetics, at the present point we can merely mention a few salient points. Melodies, rhythms, and musical harmonies are examples of aesthetic stimuli for pleasantness. Accidental causes such as constant and inopportune repetition may make them unpleasant, but intrinsically they are pleasant. Much experimentation has been made upon the affective values of colors and designs. The method used is termed the *method of impression*. In one of its common forms it consists in comparing each of many colors, color combinations, or designs with every other color, color combination, or design in the series of objects chosen for study. Each time that the observer is confronted by two of the objects he indicates which is the more pleasant. The final results can be put in the form of averages and curves which will indicate quantitatively the relative merits of the different objects as stimuli for pleasantness and unpleasantness. A similar procedure is applicable to strain-relaxation and to excitement-calm. Material is selected and graded according to its capacity to

arouse these qualities in the observer's consciousness. By these methods it is possible to determine the effect upon the affective process of changes in the intensity, duration, and quality of the sensation (object). Although the results differ markedly from one individual to another, for the same individual the data are perhaps surprisingly constant. If deep (saturated) colors are preferred or if oblongs are preferred to squares, it does not follow, of course, that this is due to the innate organization of the individual. The yellow may be associated with some happy experience or the square with something distasteful. In agreement with this we know that the objects which are considered pleasurable and aesthetic have changed greatly in historic times and do change greatly during the life of the individual. Racial tradition also seems to fix an association between certain visual qualities and certain affective states. Reds and yellows are symbols of passion and excitement. Red is the color of blood, of danger signals, and of revolutionary flags. Yellow with many peoples is a sacred color signifying aspiration. Greens and blues are cool, calm, and quieting colors. White is the occidental symbol of innocence and purity; black, the symbol of melancholy and depression. The theories for the causal bases of these associations offer most interesting problems, but problems into which we cannot enter.

Bodily Changes in Affection.—Not only must we know the stimuli that bring about affective consciousness, but we must know the organic results within the individual. Studies of the bodily changes which accompany affective states have concerned themselves with changes in circulation, breathing, muscular tonicity, and electrical potential. Here we use the *method of expression* as opposed to that of impression discussed above. One should not, however, regard the bodily changes as "expressions" of affective processes. They are the accompaniments and possibly the objective side of affection, a case similar to that which we found in the problem of the emotions and their

accompanying organic disturbances. In the study of circulatory and respiratory changes the same apparatus is used which we have described in the account of attention (p. 130). In general the only result one can be sure of is that all affective processes are accompanied by changes in the body systems referred to. There is no clear evidence that the disturbances differ according to the affective quality present. Wundt and his students are the chief champions of the opposite view. Table I gives the correlations which they claim to find between

TABLE I

Relations between the Feeling Qualities and Changes in Pulse and Breathing according to Wundt

(+ indicates an increase; − indicates decrease; = indicates no change)

Feeling	Pulse		Breathing	
	Strength	Speed	Strength	Speed
Tension	−	−	−	−
Calm	−	=	−	−
Unpleasantness	−	+	+	−
Pleasantness	+	−	−	+
Excitation	+	=	+	+
Relief	+	+	+	+

affection and organic disturbance. The work has been repeated, particularly by James R. Angell and by Shepard in this country, with results that differ from those secured by the German school. The two great sources of error that apparently render correlations of this type permanently impossible are these: (1) The affective states are difficult to control. Although the stimulus given, e.g., an unpleasant odor, may be unpleasant, the act of attending and the success of the test may themselves introduce pleasant affective qualities, or vice versa. (2) The sensory stimulation itself sets up circulatory and respiratory changes

which obscure any effect that may accompany the affection proper. The large and dominating fact that stands out from these studies is the close connection which exists between conscious states (cerebral neural processes) and bodily changes. So far, however, the study of these bodily changes has thrown little or no positive light upon the nature of the affective processes.

Affective Memory.—To what extent and in what manner do we remember experiences of pleasantness and unpleasantness? The question can well be broadened to the general one of emotional memory. To have an affective memory is to be able to reinstate or recall an affective process which has once been experienced. Many fail here, although most people can succeed in remembering that such and such an experience had such and such an affective tone. The latter case needs no comment other than will be made in the chapter on "Memory." The former possibility, on the other hand, deserves special attention.

One major difficulty in securing true affective memory lies in the fact that a remembered unpleasantness may be swallowed up in the pleasure of its successful recall. When one looks then for the old unpleasantness in the experience that is recalled, he does not find it, although he may recall distinctly what affective tone was originally present. This fact has usually been described by saying that an experience which in the beginning had one affective tone finally may emerge in memory with another. It seems probable, indeed, that the change in affective quality when the experience is recalled is due to the conditions under which the recall takes place. When I remember a boyhood experience that was pleasant, it may serve now to divert my thoughts from their proper channel and hence be unpleasant; or it may call up another experience whose unpleasantness overshadows the faint re-arousal that I had secured of the original pleasure.

Confusion has been introduced into the question through the insistence by some psychologists that if affective memory occurs, the original pleasantness must not here and now diffuse through the body and so be actually present, but must reappear as a faint copy of the original just as an image is a faint copy of its sensation. If the affective quality in the beginning is due to sensory impulses, when it is revived it must be due, it is said, to processes which originate in the cerebral cortex or in the thalamus. There is a fundamental misconception here, however, because any state of consciousness which we recognize as one of our past experiences is a state of memory consciousness. Undoubtedly in most cases of emotional memory one actually experiences faint present anger, fear, jealousy, unpleasantness, etc.; nevertheless they are memory experiences. The present solution of the question will take on added significance in the study of association and memory which we shall make later in the book.

Functions of Affection.—Throughout our study of affections, we have found correlations with our account of emotions. The question of function offers no exception to the rule, for in both processes it is essentially the same. Here with affection most of our probable knowledge is with reference to the qualities of pleasantness and unpleasantness. The most important function that has been credited to them is in connection with the fixing of associations between ideas and muscular responses (habit-formation). In connection with the topic of psychoanalysis, it was seen that the unpleasant tends to be repressed and the pleasant recalled. Furthermore, the description of habit-formation in animals gave data which would suggest that the animal eliminated those responses that led to unpleasantness and retained those that led to pleasantness. This is often referred to as "the stamping-in effect" of pleasure. This function of affection is quite probably a genuine one; only here, as in emotion, it should be held clearly in mind that not

the conscious states but the nervous processes underlying them are the agencies which "stamp in" or favor certain responses. Synaptic resistances are seemingly decreased by virtue of their association with nervous impulses underlying pleasure.

In addition to these functions, affection also confers "value" upon other conscious states (empathy) and aids in determining the content of the focus of attention by holding attention to the pleasant. Perhaps all of the functions of affection are of great ethical import. Since the Greeks it has been recognized that voluntary action or conduct is tremendously influenced by the pleasure or the lack of pleasure which the future holds in store. Certain it is that individual and national conduct is always directed toward securing *happiness*, one of whose essential elements is a mild and not too turbulent pleasure.

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CHAPTER VI

SENSORY PROCESSES

Introduction.—With the analysis of the affective processes the first part of our study is completed. At the close of the discussion of the nervous system two series of topics were before us: either we could start with the effector side of the reflex arc and study forms of muscular and glandular behavior and their conscious accompaniments (emotion and affection), or we could follow the series of topics growing out of an analysis of receptor activities (sensation, imagination, memory, etc.). We chose the former of these topics because it includes the primitive and fundamental sides of human nature—instinct and emotion—for in the chapter on "Attention" notice had already been taken of the overshadowing rôle of instinct in determining the contents of the focus of consciousness and consequently the constituents of character. In this way instincts, inherited co-ordinations of reflexes, are determiners of what sensations, images, and thoughts we shall be conscious.

In the series of topics whose study we now begin there will still be the two phases behavior and consciousness, and our account cannot be adequate without due note being taken of each. Indeed, as our previous study has indicated, much of our knowledge of neural processes and behavior is based upon the circumstantial evidence offered by the nature of conscious processes.

Definition of Sensory Processes.—*By sensory processes, or sensation, we shall understand the consciousness of any object as present to sense.* If I am aware of a color or a sound, a contact or an odor, and if I believe that it is due to the actual presence of an object to my senses, I am experiencing a sensation. My

belief may be poorly founded, and there may really be no sound or odor present. In this case we refer to the experience as an illusion or a hallucination; yet for me it remains a sensation by virtue of the belief in the physical presence of its cause. Except in rare instances the cause of the sensation is actually present and acting upon the sense-organs; and so the belief is well grounded. It is this attitude of belief that constitutes the "feeling of realness" attaching to sensation and lacking in imagination, which early psychologists referred to as the "force and liveliness" of sensation. This belief characteristic of sensation is one of meaning or significance, for the conscious experiences involved *mean* "an object present to sense."

In addition to the fundamental characteristic of force and liveliness just mentioned, sensation possesses the following attributes which it shares with all other states of consciousness: quality, clearness, intensity, duration, meaning, and location. Each of these attributes will vary in degree. The location may be more or less definite; the meaning may change both in complexity and in significance. The quality is the attribute which language has recognized with a specific name: color names refer to qualities of vision; sweet, salt, sour, and bitter are the elemental qualities of taste—and we could give examples from every sense field. In the preceding chapter we had occasion to discuss the attribute of clearness as it concerned affective processes and sensations. All psychologists agree that sensations may enter the focus of consciousness, i.e., that they can be directly attended to. Very faint and poorly localized sensations (odor, for example), however, probably enter the focus with as little ease as do affective processes. We have inclined decidedly toward the view that affection is peripherally aroused, and hence that it like emotion is essentially sensory in character. Certain attributes or characteristics of sensations are normally peripherally initiated, i.e., the nervous activities

underlying them must start from a sense-organ at the periphery of a reflex arc and then proceed to the cortical area involved. These peripherally conditioned characteristics are quality, intensity, and duration. The other attributes mentioned depend more largely upon processes arising within the brain.[1]

Sensation, Perception, and Apperception.—Many psychologists distinguish between sensation and perception on the basis of meaning. James, for example, refers to sensations as "awareness of quality" and to perception as "knowledge about" objects. Perception thus involves a relationship to past experiences (meaning), whereas sensation stands by itself simply as blueness or grayness or sweetness. In this form, however, James himself admits that sensations do not exist after the first hypothetical moment of consciousness. Only the very first experience of an infant could enter into no relationships with past experience and therefore could have no meaning, could only be an "awareness" and not a "knowledge about." It is idle, however, to spend time seriously with such sensations, and we use the term here for the simplest actual bit of sensory consciousness, thus making it synonymous with James's perception. The term *perception* is better used, if used at all, to refer to *any object present to sense which is composed of two or more sensory qualities.* If one sees a bit of blue (quality), of a certain intensity, clearness, duration, location, and meaning,[2] he experiences the state of consciousness termed sensation. On the other hand if what one sees is two or more qualities—red, white, and blue, e.g.—plus the other characteristics mentioned, he experiences a perception. The meaning this time may still be sky, or it may be flag, the only difference

[1] This is true to some extent of intensity and duration also. Hard-and-fast rules cannot be laid down. Sensory quality, however, is usually and predominantly peripheral in origin.

[2] The bit of blue might mean anything: paper, blotter, sky, etc.

between the two cases being one of qualitative complexity. In each case there is the awareness of an object.[1]

Apperception, to use Herbart's description (1816), has been defined as the reception of a new stimulation into consciousness by past experience. Past experience constituted the *apperception mass* and the novel idea or sensation was the apperceived content. Thus a child who is familiar with balls is shown an apple, which, due to his past experience, he calls a ball. From the point of view of pedagogy it is probably important to stress separately the apperceived and the apperception mass, but psychologically the description is unwarranted. Meaning is not waiting in consciousness to pounce upon and interpret new experiences. Each experience enters consciousness with a meaning just as it enters with intensity, quality, and duration. The neural process is about as follows: The nervous processes produced by earlier experiences have left traces in the synapses. When a new nervous impulse comes into any center of the brain, it is modified by the retained effects of previous excitations, the result being a state of consciousness with a certain meaning. The fusion of present activities and traces of past activity does not occur in consciousness, but outside of consciousness in the nervous system. At present psychologists make little or no use of the term apperception.

The Development of Sensory Processes with Experience.— Sensation and perception develop with experience. This change may be thought of in two ways: (1) there is a growth in the meaning of the conscious state, and (2) the individual becomes more sensitive to those stimuli that are affected by practice. The lower limit of sensitivity—the magnitude of the faintest light, touch, odor, that can be sensed—is termed the

[1] We have here written as though quality were the fundamental characteristic of sensation and as though the other attributes were attributes of it. This is not the usual case. Meaning is the most important attribute, as we shall soon see. Furthermore, one may speak as truly of a red intensity or duration as of an intense or brief redness.

lower limen or *threshold*. Practice affects this so that stimuli which before were too faint to be seen or heard now enter consciousness. This increased sensitivity is not a physiological change in the sense-organ, but a change in the nervous centers which makes them more easily excited. From the conscious side it is referred to as a change in the ease of attending to faint stimuli. The growth in meaning that occurs is usually different from this change. If two compass points, for example, are applied to the dorsal side of an unpracticed observer's hand, they may need to be set a centimeter apart in order to be felt as two. With practice, however, one comes to attach new meaning to slight variations in the contacts, with the result that the two-point threshold may be lowered to $\frac{1}{2}$ cm. In general, however, when the topic of the growth of sensation is raised, we think of the change of meaning in such cases as the growth of significance of pencils, tables, machines, houses, books, etc. We never encounter things devoid of all significance. The case may be that of a child's meeting a new machine. The machine has at least the meaning "something" or "funny thing." As the child works with it and learns its parts, assembles and knocks it down, sees it run, he is constantly securing new sensations, all of which are becoming associated and bound together. Now when he meets the machine it is no longer "funny thing"; it is "a thing with wheels" or "an object to be shown to strangers." Thus the perception has developed by an accretion of meaning. On the neural side activities in various portions of the brain have become associated with that in the occipital lobe (due to the vision of the object) so that the nervous impulse irradiates out into them from this lobe as a center. If the irradiation is toward the tactual center, the object may mean "heavy thing"; if to the auditory center, it may mean "an object that makes a certain sound." In every case of sensation and perception this brain process of irradiation is present. I *see* an object as a cold,

heavy object, although cold and heavy are not qualities of objects which affect the eye but are ones which affect the skin and muscles. This is a case where brain centers other than the visual supplement the total nervous activity and produce a state of consciousness similar to that which we have just described.

The Nature of Meaning.—The foregoing two sections have already described many important features of meaning. Meaning on the mental side is the relationship which one state of consciousness bears to others. It is very largely dependent upon experience. When, however, reference was made to the original stimuli for instincts and emotions, we were dealing with innate, non-acquired meanings. On the neural side meaning is the co-ordination of nervous activities by virtue of which a definite response is called forth in muscles and glands. Neurologically, to the chick the grains of food mean something to be pecked, and any small object may mean the same response. Furthermore the development of an instinct on its afferent, or sensory, side is, as we have already described it, a development of meaning looked at physiologically. When these neural processes are of a certain kind or of a certain intensity (when, as we say, they cross the threshold or lower limen of consciousness), the attribute of meaning appears in consciousness.

Not only is *meaning* a general characteristic of consciousness, but it is perhaps the most important of all the attributes of conscious states, because *it is the conscious representative of those neural connections which most intimately determine the reactions of the organism.* If the meaning that attaches to the perception "table" is "support-for-books," placing books upon it will be the response I make or plan to make. If I am accustomed to perceive a chair with the meaning "object-to-be-sat-upon," it will be difficult for me to react to it as to a table because it is only with difficulty that that meaning will attach to it. Meaning is of great importance, therefore, from the

standpoint of behavior. It is also of great importance from the standpoint of consciousness. Practically all tables that I see are rectangular. I see them as rectangular, and yet perhaps never have I actually seen the table when the angles truly subtended at my eye were not oblique. Again, as a person walks toward me his apparent size constantly increases, and as he walks away it diminishes. These changes in the size of the object *mean* a change in distance, and the changes come to consciousness in this form. I actually do not *see* the variation in size; I see the meaning. These are sample cases where the meaning of the perception (and the same is true of sensation) overshadows its other attributes. I regard the above rectangular table, for example, as brown in color-quality, and yet the actual color I see varies constantly with the angle from which I observe it, with its distance, with the intensity of light, and with various other factors. Bishop Berkley (1710) and Thomas Reid (1764) were the first psychologists to stress this point. These instances are cases of "standardized meanings." It is these standardized meanings, these results of fixed neural connections, that common sense calls the real object and by which it governs its responses. For the common man the table *is* brown and *is* rectangular, and he so treats it.

The Classification of Sensations.—When we are discussing sensations we are considering a group of conscious states that are literally as different as black is from white or as sweet from sour, and yet that all possess the general characteristics of sensations. We shall find it profitable, therefore, to consider briefly the question of classes of sensations.

There are many different classifications of sensation, all of which are valuable but no one of which is thoroughly satisfactory. Hearing, kinaesthesis, touch, and the static sense are often referred to as the *mechanical senses* inasmuch as they are aroused by mechanical stimuli. Taste, smell, and vision are, then, the *chemical senses.* Pain will fall under either grouping

because it is called forth both by mechanical and by chemical action. Cold, warmth, and the organic sensations cannot be definitely placed in this scheme. Opposed to this method, common sense groups sensations upon the basis of the apparent sense-organ involved: vision, hearing, touch (all sensations from the skin), taste, and smell. The grouping in this form is inadequate for at least two reasons: (1) it is superficial and does not get at all of the sense-organs; and (2) it passes over the fact of fundamental biological value that certain sensations are aroused by objects that act from a distance, certain others by objects that act upon contact with the body, and by still others that are effective within the body. Psychology points out that there are four kinds of sensations from the skin—cold, warm, pain, and contact—with separate end-organs for each. It advances evidence indicating that taste is a name for four senses—sweet, salt, sour, and bitter—and that vision and hearing themselves may each be names for two senses.

The most satisfactory classification (a scientific adaptation of that of common sense) is based upon the differences between receptors, proposed by Sherrington.[1] In its essentials it is as follows:

1. *Proprio-ceptors*—receptors lying between the external surface of the body and the internal surface (alimentary tract) and chiefly located in the muscles, joints, tendons, and semicircular canals of the ear (static sense). The stimuli involved are due to the organism's own activity, muscular and glandular.

[1] Titchener has proposed that sensations be classified upon the basis of "introspective similarity," a classification from the standpoint of consciousness rather than of behavior. Red is said to "feel" more like green or black than like sour or pain. It is said that we are able to pass from red to any other visual quality gradually, whereas we cannot do this from red to sour. Although the problem is too large for discussion in an elementary text, we may point out that it is possible to pass from taste to smell without a break on the conscious side, i.e., without the observer knowing which sensory quality he is experiencing. So it is possible to pass from touch to

The conscious qualities that result are largely kinaesthesis, pain, and heavy pressures.

2. *Intero-ceptors*—receptors lying along the alimentary tract and stimulated by that portion of the external environment there included. Taste, thirst, pain, and temperature sensations from the stomach are the conspicuous conscious states concerned. Hunger is partly intero-ceptive and partly proprioceptive (or kinaesthetic).

3. *Extero-ceptors*—receptors in the external surface of the body, stimulated by changes in the outer environment. Included here are vision, hearing, smell, and the cutaneous senses (contact, cold, warm, and pain). This class is divisible into *distance receptors* and *contact receptors*. Contact is the only extero-ceptor that cannot be a distance receptor. Vision, hearing, and smell receptors will each respond to contact-stimulation of their gross structure (blows on the head and odorous substances in the nose). Pain and temperature receptors will respond either to stimuli acting from a distance or to those acting in contact with them.

As a supplement to this classification, it is of much biological importance to note that the distance senses have different functions as a result of the kinds of stimuli which affect them. One of these stimuli, light, is transmitted only in a straight line. Vision is therefore the sense best suited to spatial discrimination, i.e., to the perception of size, form, and distance. The other stimuli of heat, odor, and air-vibrations (hearing) will bend around intervening objects. They are, therefore, not

kinaesthesis; from nausea to taste and pain; and from many other classes of sensations to other classes without the observer's being able to detect a break in the continuity of the transition. Furthermore, it is certainly open to serious question whether red is more like green or black more like white than either quality is like sweet or sour. The apparent differences are largely due to different meanings and settings of the experiences and not to variations in the magnitude of qualitative differences.

suited to give an accurate report of the space characteristics of an object, but they find their great value in acquainting the organism with the presence of objects which are not in an unobstructed straight line from the sense-organ. In this way food, mates, and enemies are detected, although they may be screened from view. It is to be borne in mind that sense-organs, receptors, are structures in the body which have been developed and specialized with a view to making it possible for the animal to react to certain forces in its environment. They are the places on the organism that are particularly sensitive to light, sound, heat, and other stimuli. Many forces, such as X-rays and ultra-violet light, do not in nature stimulate the human organism, because there are no receptors adjusted to them. It is an open and possibly an unanswerable question whether man could adjust himself to his environment better if he possessed receptors for those forces which are not now effective.

Sensory Qualities.—The problem of sensory qualities is the central problem in sensation. What are the simple odors, the simple colors, the simple tones? What are the variations in the consciousness of these sensations which result from changes in their stimuli? What, for example, is the result in consciousness of combining sweet and salt solutions? What are the sense-organs underlying those sensations, and what processes occur in them as conditions of the states of consciousness concerned? What goes on in the eye that results in a sensation of red? In no case can this last type of question be answered by direct observation as one would observe a process under the microscope, for one can only infer what processes go on in the sense-organs from the nature of the states of consciousness which the subject experiences. This will be clear as our account proceeds. From the standpoint of behavior the analysis of sensory processes is a study of those aspects of the stimulus which can arouse muscular and glandular

activity. Quality is one important aspect. From the standpoint of consciousness the analysis of sensory qualities is fundamental because most, if not all, other states of consciousness are reducible to these elemental qualities.

Taste.—The elementary qualities of taste are sweet, sour, salt, and bitter. In the past, alkaline and metallic were included also; but the former can be produced by a mixture of sweet and salt or of sweet and bitter, and the latter by a mixture of salt and sour. In everyday experience many more "tastes" are recognized. These "tastes," however, not only are mixtures of the above elemental tastes, but also include touch, temperature, smell, and kinaesthesis. Thus an integral part of toast is its crispness (touch and kinaesthesis), and the chief part of the "taste" of coffee is its temperature and odor. It is this odor component of so-called tastes that is the most surprising, for substances which are ordinarily considered to possess gustatory properties, if applied to the tongue when the nostrils are plugged, are often found to be tasteless.

The following important phenomena lend support to the hypothesis not only that sweet, salt, sour, and bitter are the elemental taste qualities, but also that each may be served by a separate kind of end-organ. In this case taste would be a term covering not only one but four different sense-fields. (1) Sweet and salt have the lowest limen at the tip of the tongue. Sour is best sensed on the sides and bitter at the back of the tongue. (2) Small areas of the tongue can be found that will respond with only one quality (sweet, for example); others with two, three, or four qualities. (3) Certain substances have one taste on one part of the tongue and another on another part. Thus, saccharine tastes sweet on most of the tongue but tastes bitter at the back. (4) Certain drugs act selectively upon the different taste processes. A 10 per cent solution of cocaine, if applied to the tongue, will anaesthetize it (render it insensitive) first to bitter and then, as the application continues, to sweet,

salt, and sour. Gymnemic acid destroys sweet and bitter, but does not affect the other qualities. Such losses of taste are termed *ageusia.* To the extent that these four groups of data indicate that sweet, salt, sour, and bitter will vary independent of each other, to that extent they indicate the existence of four senses rather than of one.

In addition to the phenomena which we have described, those of mixture, contrast, and the lower limen of sensitivity deserve notice. *Mixture* has already been referred to in the case of alkaline and metallic tastes, which we found to be compounds of several of the elementary tastes. By *contrast* is meant that one taste is increased in intensity by virtue of the fact that it is experienced simultaneously with, or in immediate succession to, another taste. Thus, eating sweets makes one particularly sensitive to acids and salts. Copper sulphate on the tongue makes cigar smoke taste sweet. Bitter is the least affected of the four taste qualities. The most striking case of contrast occurs when the two substances are applied simultaneously to opposite sides of the tongue. If a salt solution too weak to be tasted as salt is placed upon one side of the tongue and a mediumly strong sugar solution is placed upon the opposite half of the tongue, the salt will be sensed. It is interesting to note in this connection that the two halves of the tongue are supplied with nerves from opposite sides of the brain; consequently the two chemical processes and the two nervous processes cannot interact in the tongue. With reference to the third phenomenon mentioned above, notice can be taken only of the fact that the thresholds are increasingly higher for bitter, sour, salt, and sweet in that order. Many substances such as cranberries taste sweet, but if a drink of water is taken a bitter taste is left. The water has weakened both the sweet and the bitter, but inasmuch as the tongue is much more sensitive to bitter than to sweet, the former still affects the sense-organs after the sweet has gone.

The sense-organs for taste are ciliated cells contained in the taste-buds that line the walls of the crevices of the tongue (Fig. 36). In adult humans these taste-buds are found only on the upper surface of the tongue (the middle excepted), in the soft palate, and on the posterior side of the epiglottis, while in children they are also found in the cheeks and on the middle of the tongue. In fish, taste-buds are often found scattered over the external surface of the body and on the barbules. Taste in man is supplied by the VIIth and the IXth cranial

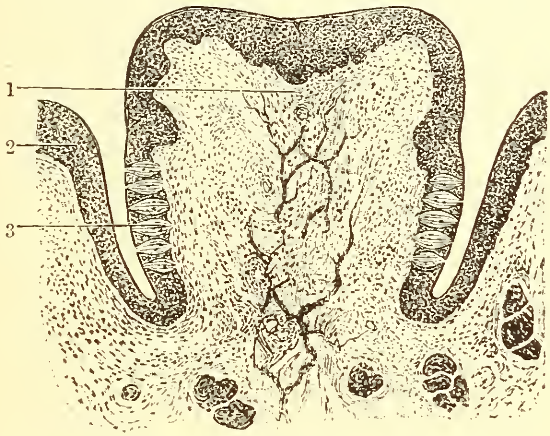

Fig. 36.—A section through a papilla of the human tongue. 1 is the papilla; 3 is the taste-bud (after Cunningham).

nerves. The cortical center is not definitely known but is probably near the hippocampus. The stimulus for taste is in liquid form, thus facilitating its access to the receptors.

Smell.—It has already been pointed out that taste and smell are so closely related that it is often impossible to distinguish between the feel or quality of a complex taste and that of a smell. The similarity is equally prominent on the behavior (objective) side. The essential sense-organs for smell are ciliated cells in the mucous membrane of the nose, differing from the taste-cells in that they are cell-bodies of neurones,

whereas the taste-cells are receiving structures only. Figure 37 shows the area in the nose supplied by the olfactory, or Ist cranial, nerve.

Parker and Stabler have made tests upon the relative sensitiveness of taste and smell with ethyl alcohol as the stimulus for each sense. The results indicated that smell is approximately 24,000 times more sensitive than taste. It is essentially a distance receptor for stimuli that bend. Although the

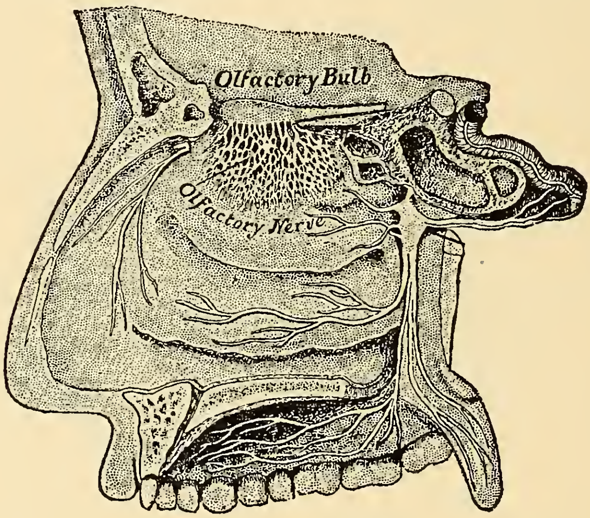

FIG. 37.—The distribution of the olfactory nerve in the nasal cavity as it comes from the olfactory bulb, which is attached to the lower portion of the frontal lobe of a cerebral hemisphere (from Herrick after Wood).

stimulus for smell is usually said to be odorous particles in gaseous form, Parker and others have shown that fish have the sense of smell, and it is known that the olfactory membrane in man is constantly bathed in mucus. It is therefore quite probable that the stimulus in each sense is a liquid, and that the two senses differ essentially only in degree of sensitivity. Opinion is divided upon the relative priority of the two in animal development.

So far experiment has presented less evidence that smell is a term applied to several senses than we found in the case of taste. In neither instance does the microscope reveal different classes of ciliated cells. Those for smell are uniform, and so are those for taste. Classifications of odor qualities, however, are a step on the conscious side toward the discovery of the simple elements of smell if they exist. Additional facts are gleaned from cases of partial loss of power to smell (*anosmia*) and from studies of olfactory fatigue. In these instances, due to accident or to laboratory conditions, certain odors fail to stimulate the receiving organs, and as a result the sensations derived from many other odors are modified. Fatiguing the olfactory membrane for iodine, for example, will, according to Arnsohn, destroy the power to smell alcohol, heliotropine, and other odors; it will weaken the odor of hyacinth, oil of mace, oil of citron; and it will either strengthen or leave unaffected ether and other odors. It is by tests of this type that it is possible to determine the components of complex odors; because, if X is exhausted and the complex XY is then presented, X cannot be smelled and so only Y remains. Further evidence on the existence of elemental odors is gained from observing how certain odors change in character as one smells them until complete fatigue results. It seems probable that these changes are due to the successive fatigue of component odors.

The study of smell has been carried out largely with the olfactometer (Fig. 38). The principle of the apparatus, which is due to Zwaardemaker, is that the intensity of the odor in question is proportional to the area of the odorous surface which extends beyond the glass tubes shown in the figure. The following phenomena are the chief ones observed in studies with this apparatus. If one odor is conducted to one nostril and another to the other nostril, either of three results may be secured: the odors may mix and give rise to a new odor; they may cancel each other so that no odor is sensed; or they may alternate in

consciousness (rivalry). Which result is secured will depend partly upon the odors chosen, and partly upon their relative intensities. In these cases where the two odors are conducted to different nostrils, it is of interest to note again that they affect nerves which are interconnected only in the brain. No fusion in the sense-organ can therefore take place. The "odors" of everyday speech, like the "tastes," involve the sensory

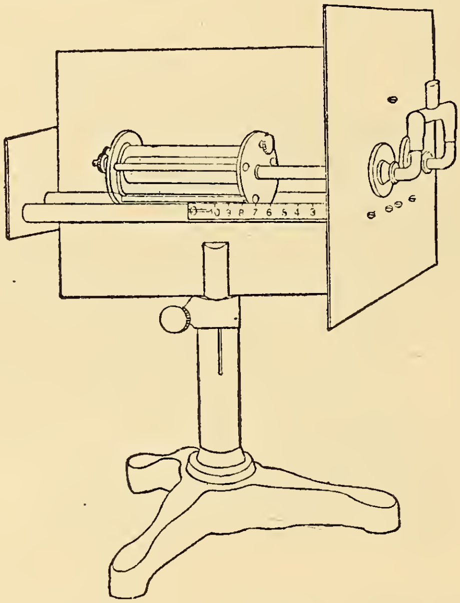

FIG. 38.—An olfactometer. The odorous substances are placed in the cylinders which slide above the scale. A glass tube projects into each cylinder and conducts the odor in varying intensity to the subject's nose.

qualities of touch and kinaesthesis, because many "odors" sting and smart or are soft and heavy, while others produce muscular movements of the nose and face.

Cutaneous Sensitivity.—There are four distinct senses whose receptors lie either in the skin or just beneath it: cold, warm, touch, and pain. Figure 39 shows the types of receptors involved. The bulb of Krause is the receptor for cold; the end-organ of Ruffini mediates warm; pain is served by the free

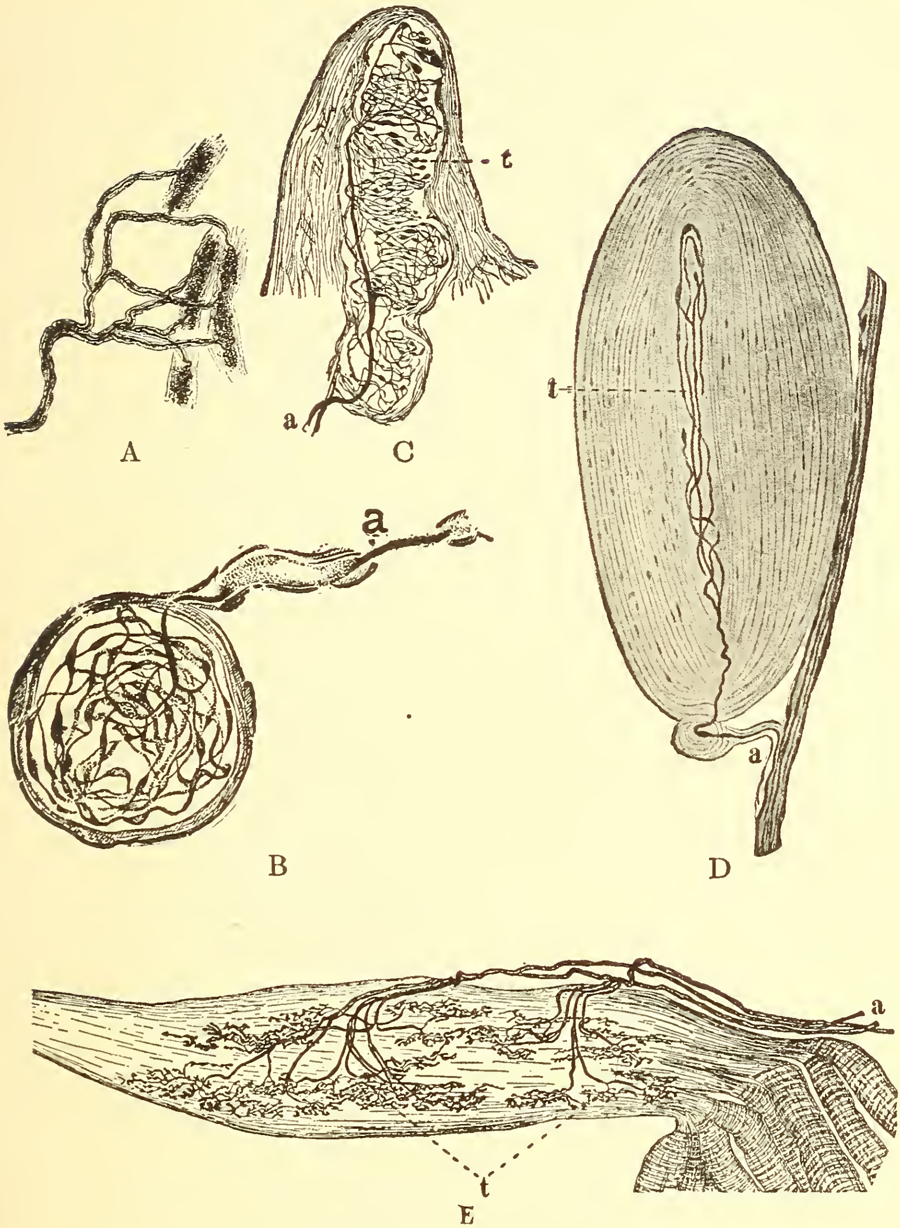

FIG. 39.—Types of cutaneous and kinaesthetic receptors (from Morris and Quain). *A*, end-organ of Ruffini; *B*, end-organ of Krause; *C*, Meissner's corpuscle; *D*, Pacinian corpuscle; *E*, nerve ending in a muscle.

nerve endings; and the receptors for touch are Meissner's corpuscles, the nerve endings at the roots of the hairs, and the Pacinian corpuscles. In each case, with the exception of that of pain, the receptor is a structure in which the dendrite of the sensory nerve begins. The determination of the different end-organs is aided by the fact that they are variously distributed over the body. The free nerve endings are particularly numerous in the cornea of the eye (the clear surface covering the iris and pupil), and this area is very sensitive to pain. On the other hand an area on the inside of the cheek lacks these

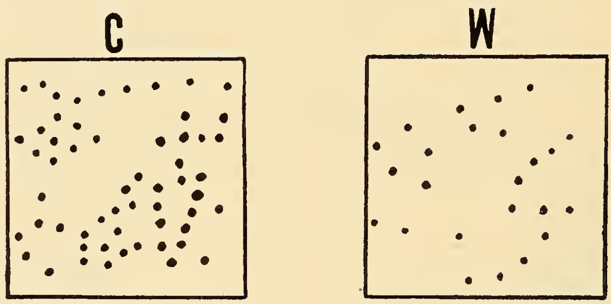

Fig. 40.—Cold, *C*, and warm, *W*, spots on the dorsal surface of the forearm (after Goldscheider).

fiber endings, and no pain can be produced there. The end-organs of Krause are especially numerous on the inner surface of the eyelids, on the white of the eye, and on the forehead, and these areas are particularly sensitive to cold. Likewise along with the delicate sensitivity of the finger-tips to contact goes an increased supply of Meissner's corpuscles.

Common sense assumes that the entire skin is sensitive—an assumption that is made partly because the objects of every-day life usually stimulate large areas on the surface of the body. If the skin is explored point by point, however, it is found that only certain points will respond with sensory qualities. Figure 40 shows a map of this punctiform distribution of sensitivity as prepared by Goldscheider. It will be seen that the numbers

of cold and warm[1] spots vary even on a small area. Experimenters have estimated that there are from 2,000,000–4,000,000 pain spots on the body, 500,000 each of cold and touch, and 30,000 warm spots. The hairs scattered over the body act as levers to increase the force of pressure on the skin and also serve to decrease the area stimulated, thus making the skin more sensitive, i.e., lowering the threshold of sensitivity.

The stimulus for touch, however, is not merely mechanical pressure on the skin, for if the hand is inserted in water of body temperature or in mercury, for example, pressure is felt only as a ring at the upper level of the fluid. Accordingly a *pressure gradient* from low to great intensity, such as that which occurs around the edge of an object pressing upon the skin, constitutes the stimulus for touch. The stimulus for warm and cold is involved in too much controversy to be presented here. It is, however, bound up fundamentally with what is termed the *physiological zero.* The physiological zero is the temperature to which any particular area of the skin is adapted, i.e., temporarily insensitive, the limits within which this may occur being usually given as 11°–39° C. Any increase in temperature above the momentary state of adaptation is felt as warm, any decrease as cold. By passing gradually from one temperature to a higher or lower and allowing the skin to adapt at each point, it is possible to do severe injury to the organism without its being aware of the fact.

The stimuli for pain may perhaps be generalized as "injury to the body," although much injury in the way of tumors and cancers involves no awareness of pain. Pain receptors are often termed *noci-ceptors.* At a certain intensity all stimuli affect the noci-ceptors and are felt as pain. The rate at which the increase in intensity occurs is an important condition of the phenomenon. Sudden heat will cause pain, but the same

[1] The sensation of heat arises from the simultaneous stimulation of cold and warm spots.

temperature gradually attained will not. Slow pressures, on the other hand, will cause intense pain, whereas the rapid pressure of a knife or bullet may cause none. It is also of interest in this connection to note that the nervous impulses underlying emotion block, more or less perfectly, those for pain. Thus persons may sustain severe wounds during emotional excitement in ignorance of their occurrence. Injury to the viscera apparently causes no pain unless the peritoneum is involved. Noci-ceptors are undoubtedly stimulated in these cases, but the nervous impulses fail to reach the cortex and accordingly do not condition consciousness.

Because of the correlation of pain and injury, the subject is of great importance in medicine. On page 77 reference has already been made to the loss of pain (*analgesia*) in hysteria. At this point brief mention is to be made of *propagated pains*, instances where pain is not localized at the seat of injury and stimulation. There are two classes: *referred*, or *projected*, *pains* and *associated pains*. The former are those pains which are located at the terminus of the nerve although the injury is to the nerve trunk. Pains felt in an amputated hand (which therefore is no longer present) constitute a striking case. Associated pains are located in the terminus of one nerve, whereas the injury is at the terminus of another. This results from a transfer of the nervous impulse from one pathway to another within the central nervous system. One may have severe abdominal pains from eye strain; pain in the forehead from eye defects; pain in the knee from toothache or hip-joint trouble; pains in the head from intestinal and uterine disturbances, etc. The faulty localizations that are characteristic of associated pains are due to the excitation of brain areas that are normally aroused only by impulses from the peripheral ends of certain nerves. If these impulses begin midway of the nerve or are switched in over it, the brain center responds as usual, and the pain is located in accordance with the brain's normal

response. The result is a mislocation such as we have described in the instances above.

Since 1905 there has been a well-defined tendency to regroup cutaneous sensitivity, as we have described it, into *epicritic* and *protopathic* with an additional subcutaneous class of *deep sensitivity*. This classification was proposed by Head and Rivers on the basis of experiments performed upon Head himself. After cutaneous sensitivity over a certain area of the hand and forearm had been carefully tested, the sensory nerve which supplies that area of the skin was cut and the ends carefully sutured together. As the nerve regenerated, careful studies were made of the sensitivity of the abnormal skin area. The following results were secured: (1) Deep sensitivity was not disturbed by the operation. Here belonged heavy pressure and dull pain localized deep in the tissue. These sensations were accurately localized by Head. (2) Protopathic sensitivity (called by these students the primitive cutaneous sensitivity) remained in certain areas where the epicritic was gone, and in those areas where both were destroyed it reappeared first. It included sensations of extreme cold and warm and medium intensities of touch and pain, all of which were diffuse and poorly localized. (3) Epicritic sensitivity (light touch, slight changes in temperature, and pain) was the last to return. These sense qualities were well localized. In addition to the original observations other investigators, notably Franz and Boring, have studied the question and have secured data confirmatory in general of the facts given above. Much other material that Head offers, however, cannot be accepted at present.[1]

Kinaesthetic and Organic Sensations.—Kinaesthetic sensations are derived from the muscles, joints, and tendons. In

[1] Upon the variations in sensory consciousness here described, Head proposes a radical modification in current conceptions of the cutaneous nerve supplies.

daily life these sensations are always associated with cutaneous sensations due to the stretching and relaxing of the skin during muscular responses. However, close attention to muscular strain, such as is found in lifting an object or in lifting and then suddenly releasing it, will familiarize the reader with the particular quality of these sensations. Their great tendency to fuse with cutaneous and organic sensations has impeded their study from the conscious side, though as a part of these complexes they are studied in emotion and affection. On the behavior side it seems certain that the sensory impulses arise from Pacinian corpuscles and from nerve endings in the muscles, and that they are fundamental in guiding movement and in maintaining bodily equilibrium. Wherever a series of muscular movements (walking, writing, talking) occurs, the kinaesthetic impulses set up by one movement are important parts of the stimuli for the next movement. It is thus that we traced the connection between successive reflexes in the discussion of instinct. In studies of animal behavior when the animal can be shown to solve a problem without the aid of vision, hearing, touch, taste, or smell—as may be the case in maze habits—the only remaining possibility is kinaesthetic and organic sensitivity. Much of the little that is known concerning these sensory processes is, therefore, derived from this field of learning.

It is not definitely known what the receptors for organic sensations are. These sensations are aroused by muscular and glandular activities and function during emotions, affective processes, feelings of bodily existence, bodily well-being, and other similar conscious states. Specific combinations or fusions of these sensations occur in emotion, while other equally striking ones occur in connection with the activity of the alimentary canal (food) and with the reproductive organs (sex) when emotions are either faint or absent. Hunger, thirst, and satiety are terms applying to some of these sensations. Of these

hunger has been extensively examined of late by Cannon, Boring, and Carlson and may well receive special mention here.

As a state of consciousness hunger, in its mild form, is a vague pressure-sensation referred to the region of the stomach, while in intense hunger diffuse pain is added to the pressure. In either case the pangs of hunger are intermittent. In persons who are fasting, the hunger-sensations disappear after the third or fourth day and do not thereafter return. Death from

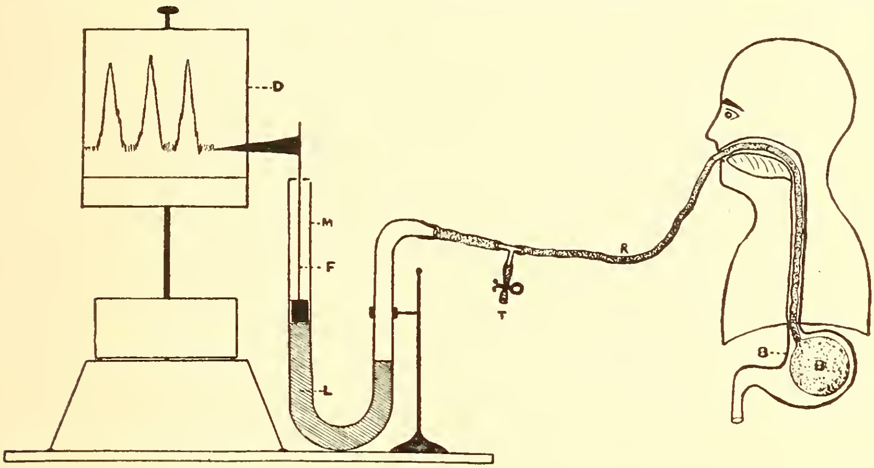

FIG. 41.—"Diagram showing method of recording gastric hunger contractions of the empty stomach of normal persons. *B*, rubber balloon in stomach. *D*, kymograph. *F*, cork float with recording flag. *M*, manometer. *L*, manometer fluid (bromoform, chloroform, or water). *R*, rubber tube connecting balloon with manometer. *S*, stomach. *T*, side tube for inflation of stomach balloon" (from Carlson).

starvation, so far as the pangs of hunger are concerned, is apparently a mild termination to life.

The most interesting experiments recently have been directed toward an analysis of the stimulus to hunger. A small rubber balloon is attached to a stomach tube and is then swallowed. The balloon is inflated sufficiently to fill the empty stomach, and the free end of the rubber tube is attached to a tambor whose marker writes upon a smoked drum (Fig. 41).

Whenever the stomach contracts, a puff of air is transmitted to the tambor, and the marker records on the surface of the drum. The subject who has swallowed the balloon has a signal key attached to another marker by means of which he can record on the drum when his hunger pangs appear and the extent of their duration. In addition a record of breathing

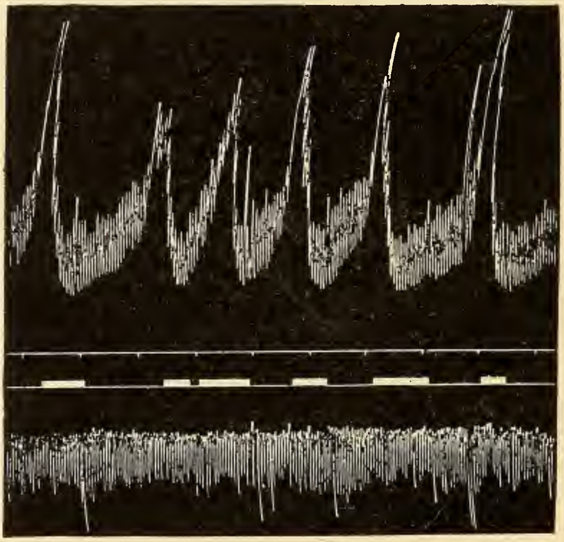

FIG. 42.—"One-half the original size. The top record represents intragastric pressure (the small oscillations due to respiration, the large to contractions of the stomach); the second record is time in minutes (ten minutes); the third record is W's report of hunger pangs; the lowest record is respiration registered by means of a pneumograph about the abdomen" (from Carlson).

and a time-record in seconds are registered on the drum. These various data are shown in the sample given in Fig. 42. It will be seen that the pangs of hunger are paralleled by the stomach contractions—a condition which has been so extensively confirmed by Carlson and his students that it may be regarded as an established fact that the stomach (and probably the oesophageal) contractions are the stimuli for hunger. The nerve

involved is the Xth cranial nerve, the vagus. The cortical center is probably the post-Rolandic area, although some evidence points to the hippocampus. Physiological changes in the blood and the absence from the stomach of material whose presence has inhibited the contractions are probably the stimuli which in their turn arouse the stomach contractions.

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CHAPTER VII

SENSORY PROCESSES (*Continued*)

Auditory Sensations.—Sensations of sound belong to two well-marked groups, tone and noise. The tones of daily life are complex and may be termed *klangs*. They are composed of a fundamental tone and various faintly sounding overtones[1] that are higher in pitch. Simple or pure tones relatively free from overtones are produced by lightly struck tuning-forks and by weakly blown bottles. A sensation of tone is smooth, continuous, and usually pleasant as compared with the roughness, interruptedness, and usual unpleasantness of noise.

Tones are classified on the basis of pitch from low to high. As a rule they occur accompanied by noise, although under careful laboratory conditions pure tones may be produced. Noises are classified as continuous, interrupted, and as beats (see p. 246). They are probably always accompanied by tone by virtue of which they appear high or low. We have so little information about noise that it is even uncertain what part of the ear is concerned. There is, on the other hand, a voluminous literature on tone-sensations and their combinations. Tone has three specific attributes: quality, or pitch, timbre, and intensity. The timbre, which is often called tonal character, is that which distinguishes a given tone on one instrument, a piano, for example, from the same tone on another instrument. We shall have more to say concerning these attributes in the following pages.

Stimuli and Receptors.—The stimuli for both classes of sound-sensation are air-waves. Disturbances in the air may

[1] Practically all sounding bodies vibrate in parts or segments as well as in wholes. The tones corresponding to these partial vibrations are *overtones*.

also stimulate touch and, indirectly, temperature receptors. However, when the alternate condensation and rarefaction set up in the air by a vibrating body equal or exceed approximately 16 per second the sound receptor (the ear) is stimulated. This vibration-rate is the lower limen for pitch-discrimination. When the frequency of the air-vibration exceeds approximately 50,000 per second it ceases to affect the ear, and we have the upper limen for pitch. In between the two limens there are some 11,000 discriminable pitches. If the air-vibrations are periodic, and if at least two complete vibrations occur, the result in consciousness is tone. If, on the other hand, the air-vibrations are aperiodic and heterogeneous, or if less than two complete air-waves strike the ear, the result in consciousness is *noise*. The pitch of a tone is determined by the frequency of air-vibration; the intensity, by the amplitude; and the timbre, by the form of the vibrations (see Fig. 45, p. 247). The form of the vibration is determined by the number and relative intensity of the overtones. We are to understand, therefore, that the middle C, 256 d.v. (double or complete vibrations), on a piano differs from that tone on any other instrument primarily by virtue of other fainter pitches (overtones) that accompany it and that do not accompany the others. By combining various fundamentals and overtones Helmholtz was able to match the tones of the chief musical instruments.

The essential end-organ for tone is the hair cells in the cochlear canal of the ear where the auditory branch of the VIIIth cranial nerve terminates. The cortical center is in the superior, or upper, portion of the temporal lobe of the cerebrum. Prevailing opinion applies the same statements to noise, although it is not certain that noise may not at least be partly conditioned by activities in the saccule and the utricle (structures in the inner ear).

The reader must rely upon a study of models and upon his instructor's presentation for a knowledge of the anatomy of

the ear. Figures 43, 44*A*, and 44*B* will, however, if carefully studied, give much preparatory information. The semicircular canals, saccule, and utricle, whose locations are shown in the accompanying figure, are connected through the vestibular branch of the VIIIth nerve with the cerebellum. They function in aiding the maintenance of bodily equilibrium and

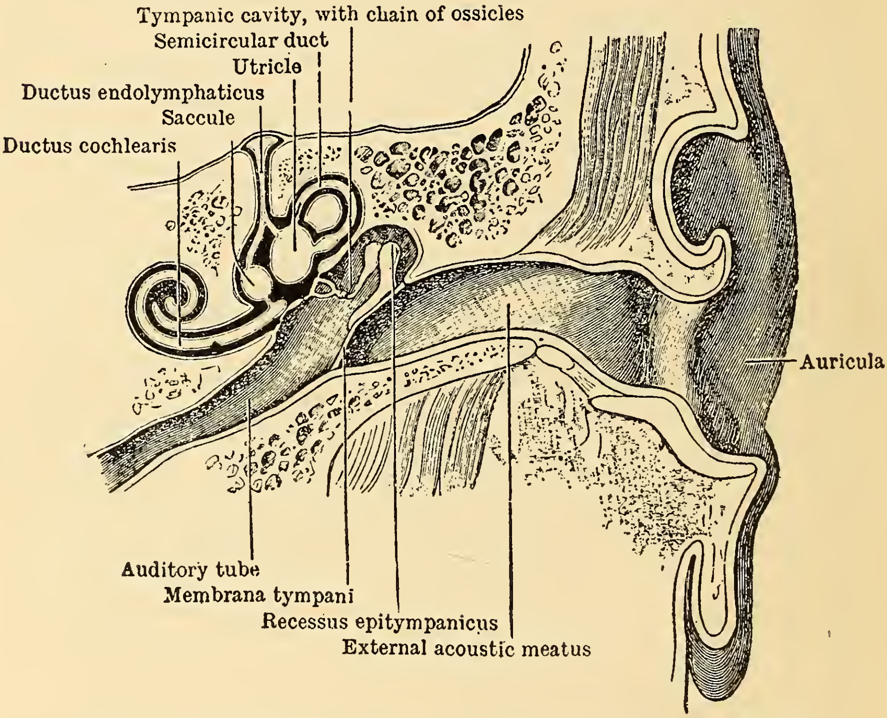
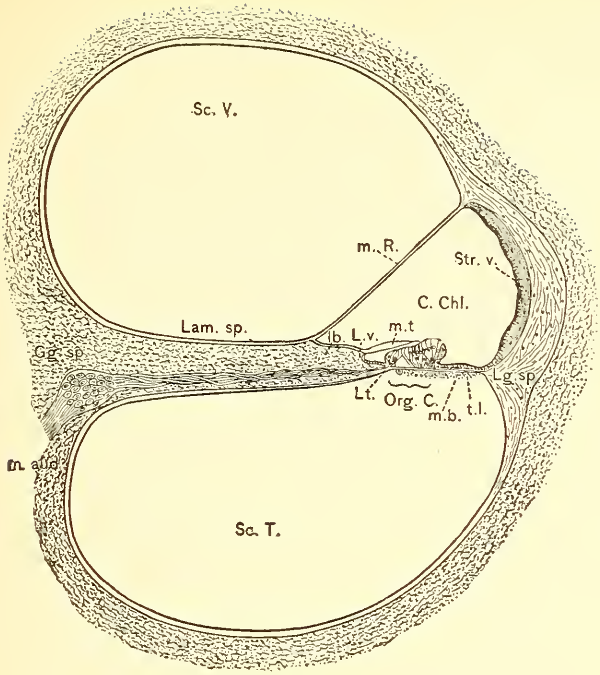
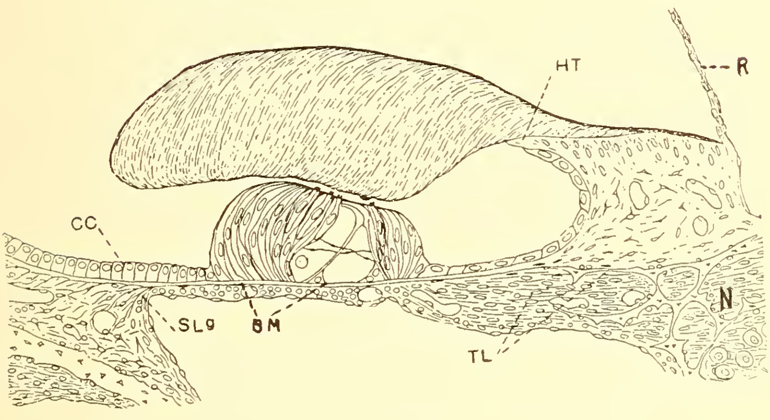


Fig. 43.—A diagrammatic view of the ear (from Cunningham)

constitute the receptors for the static sense. The canals are particularly active in rotary motion, and the saccule and utricle are probably active in motion in a straight line. In either case the motion of the body stimulates small sensory patches in the structures mentioned, the immediate stimulation being due to the inertia of the fluid and calcareous particles found in those receptors. When the body moves, these particles lag



A



B

FIG. 44.—*A*, typical cross-section of the cochlea (from Calkins after Foster). *Sc. V.* is the scala vestibuli, shown in black above the cochlear duct in the preceding figure; *m. R.*, Reissner's membrane; *C, Chl.*, cochlear duct, or canal; *m. b.*, basilar membrane; *m. t.*, tectorial membrane; *Org. C.*, organ of Corti; *Sc. T.*, scala tympani; *n. aud.*, auditory nerve; *Gg. sp.*, spiral ganglia containing the cell-bodies of the neurones making up the auditory nerve.

B, a cross-section of the cochlear duct of a pig showing: *HT*, tectorial membrane; hair cells and rods of Corti just below and resting upon *BM*, the basilar membrane. Notice that this membrane has a layer of cells on each side of it which would interfere with its free vibration. *R* is Reissner's membrane. The fibers of the auditory branch of the VIIIth nerve pass through the region marked *N* (modified after Hardesty).

behind and in this way affect the receptors. The three structures we have mentioned are termed the vestibular portion of the ear. Chief interest, however, centers upon the auditory portion of the ear, which we shall now consider.

Air-waves pass down the external acoustic meatus and set the tympanum (ear drum) in vibration. These vibrations are transmitted by the three bones of the middle ear (hammer, anvil, and stirrup) to a membranous window leading into the inner ear. Here the vibrations proceed through a liquid, endolymph, in the *scala vestibuli* for a short distance; or if the vibration is intense they may pass to the end of this passage. In their course onward the vibrations are transmitted through Reissner's membrane into the *scala tympanum* and so finally spend themselves in the vibrations of a membranous window (the round window) opening back into the middle ear. Certain structures in the cochlear canal are thrown into vibration, thus starting activities in the hair-cells. By this means a nervous impulse is initiated in the fibers of the VIIIth nerve which then passes to the central nervous system. Although the preceding account is fairly complicated, it is absolutely essential if even the rudiments of the ear's activity are to be understood.

Theories of Hearing.—Theories of hearing deal with the probable activities in the cochlear canal which underlie the consciousness of various sound phenomena (tone, noise, beats, combination tones, melody, etc.). Some of these phenomena we are soon to describe briefly. The most conspicuous theory that we have was advanced by Helmholtz. He assumes that the basilar membrane is composed of transverse fibers keyed to different pitches. These fibers are supposed to respond by sympathetic resonance to vibrations in the air and endolymph much as one tuning-fork will sound when another of the same pitch is active in its immediate vicinity. The vibration of the fibers of the basilar membrane stimulates the hair-cells, and in this way the nervous impulse is started. In support of this

theory it is known that there are transverse fibers of various lengths in the basilar membrane, and there is some evidence indicating that the broad end of the membrane subserves tones of low pitch. The chief objection to the theory, however, is anatomical, for the transverse fibers are not free to vibrate, but are interlaced with longitudinal fibers and covered on both sides with cell-layers as shown in Fig. 44*A*. Against this fact the simplicity of the theory should have no weight.

Recently (since 1905) Shambaugh and Hardesty have presented important contributions indicating that the tectorial membrane is the structure which by vibrating stimulates the hair-cells. Hardesty has constructed a large model of the cochlear canal and has shown that an artificial tectorial membrane will be set in activity by vibrations in the air and endolymph. Ewald has presented similar evidence indicating that the basilar membrane may be set into activity in ways other than that described by Helmholtz. However, the anatomical measurements made by Hardesty favor at present the major influence of the tectorial membrane.

Certain Problems in Audition.—For man phenomena of sound reach their greatest complexity in music. Music may be either a rhythmical sequence of related tones (melody) or it may in addition involve two or more related tones sounding simultaneously (harmony). The chief intervals or relationships used in modern European music are as follows:

Octave	C:C	1:2
Fifth	C:G	2:3
Fourth	C:F	3:4
Major Third	C:E	4:5
Minor Third	C:♭E	5:9
Major Sixth	C:A	3:5
Minor Sixth	C:♭A	5:8

Major Second	C:D	8: 9
Minor Second	C:♭D	15:16
Major Seventh	C:B	8:15
Minor Seventh	C:♭B	9:16
[Natural (subminor) Seventh		4:7]
Tritone	F:B	32:45

The ratios between the vibration-frequencies of the lower tone and those above it are also included here. Any sequence of tones

related according to these ratios is experienced as a unit, and constitutes a *melody*. Experiment has shown that a sequence of tones must end upon a tone whose vibration-rate is a power of two, if it is to constitute a unitary sequence. Thus, consulting our table, if we find the interval C:E 4:5 employed, the tone E is left suspended, and the sequence feels unfinished until C is again sounded. On the other hand if E:C is played, the sequence comes to a close, ending on a power of two. Likewise a falling inflection is preferred with the fifth and a rising inflection with the fourth. This rule of 2 does not explain the phenomena of melody; it serves only to classify cases of tonal sequence. Here, as is the case with consonance which we are soon to describe, many sequences that are at first felt not to be unitary are accepted after practice. It is also possible to change the pitch of one of the tones, C in the E:C sequence, for example, enough so that the ratio is no longer 2:3 and still the sequence is experienced as a melody. No explanation has been found which covers all of these facts.

In order to state even in the briefest manner the essentials of harmony, it is necessary to consider certain elementary phenomena that appear when two tones are sounded simultaneously. One of these phenomena is that of *beats*. Beats are variations in the intensity of the tonal experience, their frequency being determined by the difference in vibration-rate of the two generating tones. This variation of intensity is paralleled by an interference of the air-waves as indicated in Fig. 45. When beats are slow, from about 1 in 2 seconds to a little over 1 per second, they rise and fall gradually with a minimum of unpleasantness. As they increase in rapidity up to 60 per second, they become more and more sharp and thrust-like, finally degenerating into a blur of roughness. Throughout the scale of more rapid beats the sound complex is very unpleasant. The roughness is more pronounced in the upper regions of the pitch scale. In certain instances the beats appear

to be in one or other of the generating tones, while in other cases a tone intermediate in pitch is heard, and it is this tone that seems to beat, i.e., to vary in intensity.

When the difference in vibration-frequency of the two generating tones reaches about 80 vibrations per second, a third tone is heard which is lower in pitch than either. This is the *first difference-tone*—which introduces us to the next question to be considered in our study of harmony. Its pitch is equal to the difference of vibration-frequency of the two primary tones. There are at least five combination tones that may be

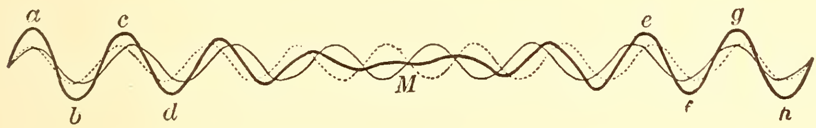


FIG. 45.—Interfering air-waves. The amplitude is one-half the distance between the top and bottom of the curves. The form of the wave is its contour. Wave-length is the distance horizontally between any two homologous points on the curve. There are eight complete wave-lengths in one of the fainter curves and nine in the other. The heavy curve is the result of the combination of the other two. There is almost a cancellation of amplitudes (intensity) in the center of the figure. This in comparison with the ends of the curve gives the physical basis of a beat.

heard by the practiced observer. The formulas by which their pitches are calculated are as follows (we shall use C of 512 vibrations per second and E 640):

		VIBRATIONS PER SECOND
D_1	$h-l$	640– 512=128
D_2	$2l-h$	1024– 640=384
D_3	$3l-2h$	1536–1280=256
D_4	$4l-3h$	2048–1920=128
D_5	$4h-5l$	2560–2560=0

Thus with these two tones the fifth difference-tone would be absent, and the first and fourth would coincide. In addition to these *combination tones*, another one, the summation tone, is

frequently heard, whose formula is *h* plus *l*. In the above illustration its pitch would be 1152 vibrations. Combination tones and beats are produced, not only between the fundamental tones, but between the overtones in klangs. Combination tones are of subjective origin, i.e., they are produced by peculiar vibrations within the sense-organ, and not by vibrations in the air.

With this preliminary account of the phenomena arising when two tones are sounded together we are now able to consider the question of consonance (harmony) and dissonance. Certain tones when sounded simultaneously are pleasing, others are less so. The more pleasing ones are the consonances. Stumpf would insist that the more consonant intervals are those that exhibit the greatest degree of fusion, i.e., those whose component tones blend together most perfectly. We know, however, that there has been a development in the history of music such that combinations of tones which were not at first regarded as consonant were later accepted as such. The relationships between tones in harmony are the same that we have indicated as occurring in melody, although here the tones are simultaneous. The harmonic intervals in their order of decreasing consonance are usually given as follows: octave, fifth, fourth, major third, major sixth, minor third, and minor sixth. Such a list as this represents the predominant opinion of skilled observers who are trained to judge the various intervals on the basis of a greater or less consonance.

Aside from Stumpf's theory referred to above, which holds that the essential element in consonance is fusion, the two most prominent theories are those of Helmholtz and Krüger. Helmholtz attributes consonance to the similarity or identity of the overtones in the generating tones, dissonance being due to beats between the overtones or fundamentals of the generating tones. Wherever such beats occur, there is dissonance. Krüger bases his theory upon difference-tones. Dissonances

are characterized by beating difference-tones and fundamentals (mistuned unisons). Consonances lack these disturbances and

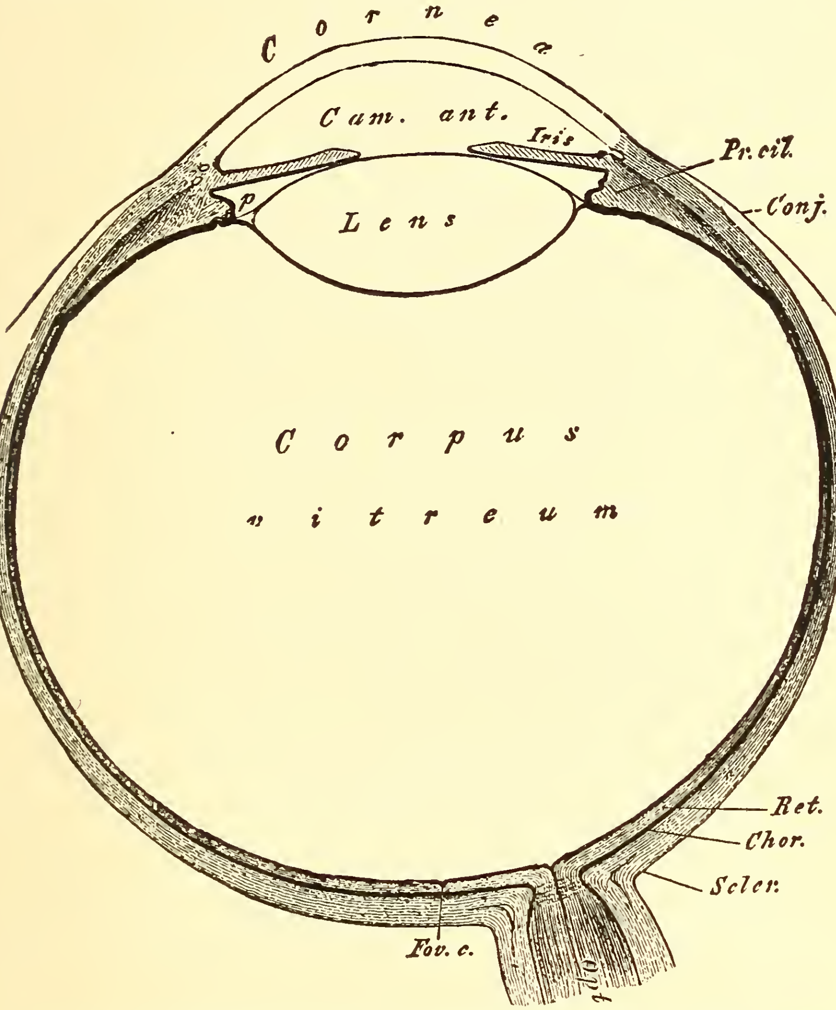


FIG. 46.—Horizontal section through the left eye (from Angell). The optic disk is the portion of the retina at the entrance of the optic nerve. *Pr. cil.* indicates the ciliary process or muscle; *conj.*, conjunctiva; *ret.*, retina; *chor.*, choroid; *scler.*, sclerotic; *fov. c.*, fovea.

furthermore possess relatively few difference-tones. Perfect consonances are rare, but all consonances sound clear, simple,

and familiar. It is impossible at present to decide between the different theories. We must, however, concede much to each of them and also to the effects of practice (Moore).

Visual Sensations—Visual Receptors.—The essential receptors for vision are the rods and cones of the retina of the eye. Figure 46 represents the eye as a whole and Fig. 47 gives the detailed structure of the inner (retinal) coat. Rays of light pass through the cornea, lens, vitreous humor, and strike upon the retina. This latter, however, is transparent, and the rays pass through the ganglion-cell layer, the bipolar layer, the rod and cone layer (shown in Fig. 47), and set up chemical changes in the outer segments of the rods and cones. These changes start nervous impulses which pass through the layers of the retina, out over the optic nerve to the thalamus and the midbrain, and then to the occipital lobe of the cerebrum, if visual consciousness is to result. The *optic disk*, in which are found neither rods nor cones but only fibers, is insensitive and gives rise to a blind spot in the visual field.[1] The *fovea* is the retinal area of greatest sensitivity. It subtends an angle of 55′–70′ from the nodal point (about the center of the lens); or, in other terms, it is 0.2–1.0 mm. in diameter. There are no rods here, only cones. As we pass to the periphery of the retina from the fovea as a center, the rods gradually increase in number relative to the cones until on the extreme periphery very few cones

[1] The reader should demonstrate this for his own satisfaction. Take two pieces of white paper each 1 cm. square, hold them side by side about 18 inches from the eyes. Close the left eye and fixate the left paper with the right eye. Now gradually move the right paper farther to the right, keeping the eye fixed on the stationary one. Soon the right paper will fall within the area of the blind spot. By moving the paper about (right to left and up and down) the exact outlines of the spot can be found. The blind spot is really a blind *cone* extending into the distance with the apex at the eye. Very large objects, if far enough away, will be invisible when they come within the cone. To find the blind cone with the left eye, close the right eye and fixate the proper object with the left eye.

are present. The choroid, which underlies the retinal layer, is a black pigmented coat that serves primarily to absorb the rays of light, thus preventing reflection within the eye. The third and last layer is the sclerotic coat, which is tough, fibrous, and practically opaque in man. It serves to hold the eyeball

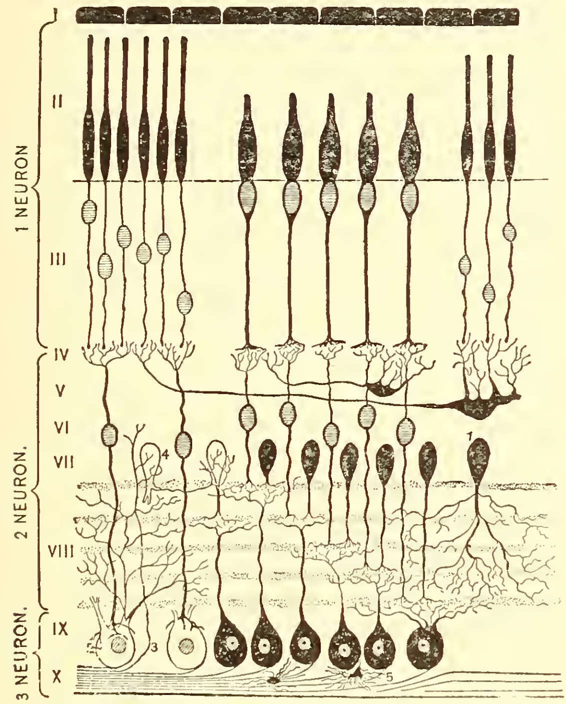


FIG. 47.—Diagram of the detail of the retina (from Howell). *1* is the choroid coat; *1 neuron* includes rods (slender) and cones; *2 neuron* indicates the bipolar layer; *3 neuron* indicates the ganglion cells and their axones which go to form the optic nerve.

in shape and to keep out the light. The adjustment of the eye to the location of an object is accomplished by two muscular mechanisms: (1) six muscles are attached to the outer surface of the sclerotic and serve to move the eye in the socket; and (2) the ciliary muscle inside the eye varies the tension on the lens, thus flattening it for far vision, or permitting it to bulge

for near vision (see Fig. 53, p. 274). The latter muscle is the mechanism of accommodation and aids in securing a sharp retinal image of the stimulus upon the retina. Changes in the contraction of the muscles of the iris vary the size of the pupil and also aid in the formation of a clear retinal image.

Visual Qualities.—Visual sensations, like those of audition, include two qualitative series—the *achromatic* or *brightness series* of black, white, and the intermediate grays; and the *chromatic* or *color series*, the elemental qualities of which are red, green, blue, and yellow. It is possible to have brightness, a gray, for example, without color, but all color involves a brightness, or intensity, value. As one passes from black through the grays to the white, one passes through a series of visual qualities each of which can be produced by a combination of black and white. The color-sensations are more complex. In the first place there are four elemental qualities in place of two, and in the second place they possess the attributes of *intensity* and *saturation* in addition to their *hue* or *quality*. The hue is the attribute named by language, e.g., red, orange, green; by saturation we refer to the purity or depth of the color; and intensity, or brightness, indicates the luminous value. These three attributes can to a certain extent be varied independent of each other. A blue, for example, may be bright or dark and yet retain the same saturation, or its saturation may vary while hue and brightness remain constant. These relationships are clearly symbolized by a figure called the color-pyramid shown in Fig. 48, to the study of which the student may well devote considerable time in order to gain a thorough understanding of many facts in the relationships of color-characteristics. The achromatic series is represented by the central perpendicular axis. The colors are arranged around the outside of the pyramid with the four elementary colors at maximal saturation located at the four corners of the base. From the base-line toward the top are the tints, or brighter colors, while toward the bottom

are the shades, or darker colors. In each case, as black or white is approached, not only is the brightness value changed, but there is a decrease in saturation. As one passes horizontally from a given point toward the black-white line, the hue and

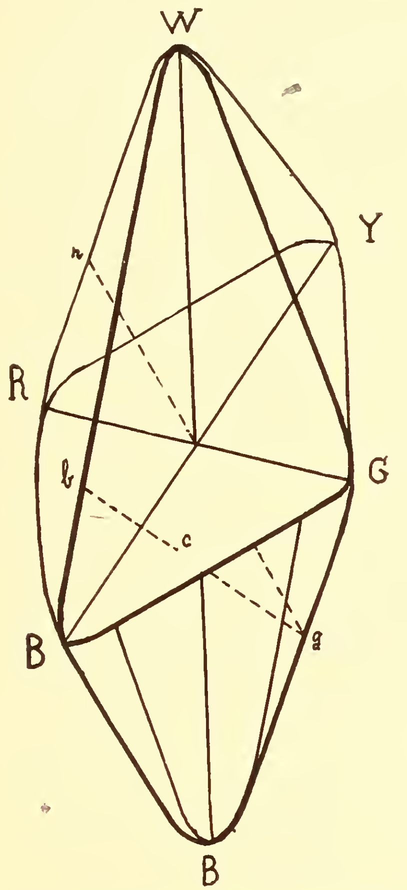


FIG. 48.—Color-pyramid described in the text

brightness remain constant, but the saturation decreases. In order to change the hue one must pass around the black-white line.

The hue of a color-sensation is correlated with the wave-length of the ray of homogeneous light that is stimulating the

eye. Its saturation is determined by the purity of the ray, i.e., its freedom from light of other wave-lengths, and its brightness is determined by the intensity of the light-ray. Achromatic sensations result from a great variety of causes. Ordinarily heterogeneous light-waves, so-called white light, produce the qualities of their series by variations in intensity.[1] But under certain conditions light of a single wave-length, which would ordinarily be seen as red or violet or some other color, will be seen as achromatic. These conditions are: very high or very low intensity, the rapid alternation of one wave-length with a certain other wave-length (called its *complementary color*) so that the two stimulate the same portion of the retina in rapid succession, and the stimulation of the eye from the periphery of the field of vision. First let us comment upon the effect of light-intensity upon hue. If a light-ray of certain wave-length (567 $\mu\mu$[2]) that ordinarily is seen as yellow is started at zero and increased in intensity, there will be a certain amount of increase before it is seen as *yellow*. A continued increase will make the quality lighter and lighter until all color is lost and it becomes white. The same condition holds as the color is darkened toward black. The interval between the threshold where the light is seen and the threshold where the color is seen is called the photochromatic interval (not shown on the color-pyramid) which varies in magnitude with the different wave-lengths (color-hues). The variations in hue with change of intensity are too complex to attempt to represent on the pyramid. The second condition for producing achromatic light by means of color-stimuli is discussed in the following section.

Color-Mixture and Complementary Colors.—If two disks of colors are placed upon a rotating spindle called a color-wheel,

[1] Black, although correlated with the absence of light, is not the absence of sensation. It is a genuine sensation quality.

[2] Millionth of a millimeter.

by rapid rotation they will mix into a third color. For the normal human eye any color may be matched by a proper mixture of red, green, blue, and yellow, e.g., red and blue will give purple. On the color-pyramid the character of particular mixtures can be determined by taking a point between the colors and noting the relative amounts of the hues involved. A mixture of a blue tint (point *b*), for example, and a shade of green (point *g*) will give a poorly saturated blue-green of medium brightness (point *c*). There is one case of color-mixture that is of particular importance—the second of the conditions of achromatic vision that we mentioned in the preceding section. *For every hue some other hue can be found which, when mixed with it, will give not a color but a gray. These hues are complementary colors.* To find the complement of any color by means of the color-pyramid, draw a straight line from the point representing that color through the base-point of the black-white line to its intersection with the opposite surface of the pyramid. This intersection point will give the complementary color. In Fig. 48 the dotted line shows that a shade of green is the complement of a tint of red, *r*. The lighter grays may also be said to be the complements of the darker grays, for a light gray mixed with a dark gray will give a medium gray.

Simultaneous Contrast and After-Images.—Every color or brightness tends to tinge its surroundings with a quality essentially its complement. A white or light object tends to darken the surface immediately contiguous to it, and a dark object tends to lighten it; or, as we say, each visual quality induces its complement in the surrounding field.[1] A red object tends to tinge its contiguous objects with a blue-green. In a similar manner shadows on snow are blue because of the yellow in the sunlight, and the shadows on white paper from a green

[1] The phrasing here is for convenience. One color (sensation) does not change the visual qualities that are located contiguous to it. The action is in the retina and in the central nervous system.

study-lamp can be seen to be reddish. As a result of this simultaneous contrast each object tends to take on added distinctness.

After-images[1] are of two kinds, positive and negative. The positive after-image has the same hue and brightness as the original sensation. The negative after-image is the complement of the original sensation in hue and brightness and is an instance of successive contrast. If one glances but for a second at a red object and then either shuts his eyes or turns them quickly to a uniform surface, the positive after-image can be clearly seen. It is most evident with unpracticed observers when stimuli of high intensity are used, such as the sun or a 16 c.p. electric light. Carr has recorded a case, however, where the individual's positive after-images of mediumly light objects were so strong and persistent that the subject could not see other objects through them. Shortly after the positive after-image fades the negative after-image appears, which, as we have said, is the complement of the original stimulus. The student may easily experience this phenomenon by looking a few seconds at any clear patch of color or brightness, and then fixating some uniform surface.

Peripheral Vision.—The retina is not equally sensitive to color throughout its extent. If one fixates constantly a given point and moves a small square of red paper from in front of the point on out to the limits of the field of vision, the red soon ceases to appear red. It may gradually assume a yellow hue, and a little farther out it will turn gray—our third condition for producing achromatic vision by means of color-stimulation. There is a certain red containing just a trace of blue which in passing from central to peripheral vision does not change its hue but goes directly into gray. Likewise there is a certain green, a certain blue, and a certain yellow that pass directly into mere brightness. The instrument used in mapping the

[1] They are not actually images, but are after-sensations.

extents of these *color-zones* is termed a *campimeter*, or perimeter, one of which Fig. 49 represents. The data derived from this experiment indicate that in all directions from the fovea red and green are seen only for a certain short distance, blue and yellow extend farther out, and after this only the achromatic series is visible. We are immediately reminded of the way in which the

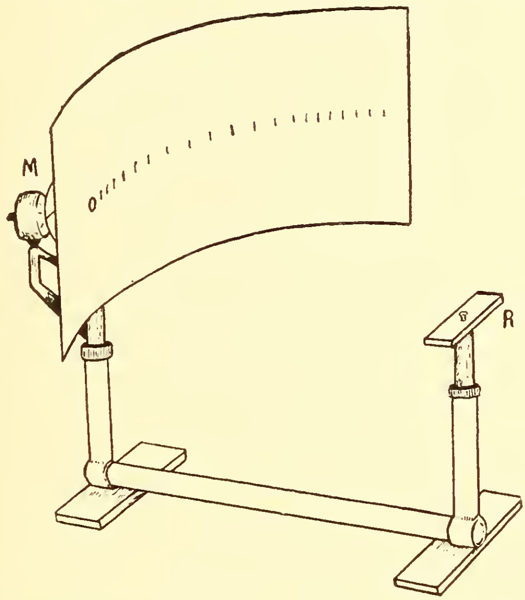


FIG. 49.—Campimeter for plotting the distribution of color-sensitivity in the retina (modified after one by Carr). *M*, motor and color-disks behind the campimeter screen. This screen and the metal closing the aperture can be of any brightness from black to white. *R*, the head-rest. The screen is arranged in the figure to test the nasal part of the right eye or the temporal part of the left eye. It can be rotated in order to test the other portions of the retina.

rods and cones are distributed in the retina—in the fovea cones only, toward the periphery more and more rods and fewer and fewer cones. The further significance of this fact we shall comment on later in the section on "Theories of Vision." Ferree and Rand have probably secured the best experimental control of the factors influencing the extent of the color-zones, the most

important of these factors being: (1) the size of the color-stimulus, (2) the general illumination of the room, (3) the brightness of the pre-exposure (i.e., of the object which is used to close the aperture in the screen of the campimeter and which therefore affects the eye just before the color is exposed), and (4) the brightness of the screen surrounding the aperture. One can hardly generalize the results without some error. As a rule, however, the extent of the color-zones is less with: (*a*) a decrease in the size of the object (area of the screen aperture); (*b*) a decrease in general illumination; (*c*) a pre-exposure which is very much brighter or darker than the color tested; and (*d*) a surrounding screen which differs markedly from the color-stimulus in brightness. The last two factors may be explained by the fact that white added to a color decreases its saturation far more rapidly than does an equal addition of black, and by the fact that each has a greater effect than a gray of the same brightness as the color. A small sector of yellow in black can be distinctly seen when rotated on a color-wheel while the same amount would remain invisible if added to white. This condition is true regardless of the method of adding the black or white, whether by actual mixture on the wheel, by simultaneous contrast (surrounding field), or by the negative after-image (pre-exposure).

Ordinarily we do not notice that objects in the periphery of vision are colorless. This fact is due partly to suggestion on the basis of what we know concerning the color of the object, partly to frequent eye-movements that reveal the color, and partly to the great size of many objects, e.g., walls and houses, which actually brings the color above the threshold.

Color-Blindness.—We have already discussed the fact that the normal human eye is color-blind under conditions whereby homogeneous light-waves (colors) arouse only achromatic sensations. Certain individuals are termed color-blind because they are unable under any circumstances to see certain colors. The

defect may be due to disease or it may be congenital, being inherited in the latter case according to Mendel's law. Color-blindness may be total. In this case the individual sees all objects in blacks, whites, and grays. Usually, however, color-blindness is only partial, and the individual is insensitive to certain rays only. Those persons more insensitive to the long rays than to the short are termed by von Kries *protanopes* (red-blind), while those less sensitive to the short rays than to the long are termed *deuteranopes* (green-blind). Occasionally one finds *tritanopes*, who are blue-blind and who may confuse blues and yellows. This condition of color-blindness is a result of disease and is very rarely found.

The detection of the protanopes and deuteranopes is particularly important because of the use of red and green lights on railroads and steamship lines. Two prominent methods of diagnosis are employed. One, the Holmgren wool test, is widely known and used for rough examinations. A large number of varicolored skeins of wool are placed before the subject who is instructed to place all skeins of a given hue into one pile. The protanopes ignore the element of red in the skeins and class together the reds, oranges, and yellows, and the blues and purples. The deuteranopes ignore the green element, and consequently place a greenish yellow with green, and a blue-green with blue. The other method, which yields more accurate data concerning the exact nature of the individual's defect, requires him to match each of the various hues of the spectrum with a combination of two wave-lengths. (In the normal eye this is only possible with three wave-lengths.) Figure 50 shows results obtained by Koenig. Thus both the red-blind (protanopes) and the green-blind (deuteranopes) can match any hue from red to orange by merely increasing the intensity of the wave-length 645 $\mu\mu$ (red). From orange on a varying amount of blue (460 $\mu\mu$) must be added in order to match the hues. The abscissa records the wave-lengths of the colors to be matched,

and the ordinate values show the relative amounts of the red and blue required. Thus blue-green (500 $\mu\mu$) is matched by the protanope by 5 units of red (645 $\mu\mu$) and 3 units of blue (460 $\mu\mu$). The deuteranope requires the same amount of blue but, being less insensitive to the long wave-lengths than is the protanope, only 2 units of red in order to make the match.

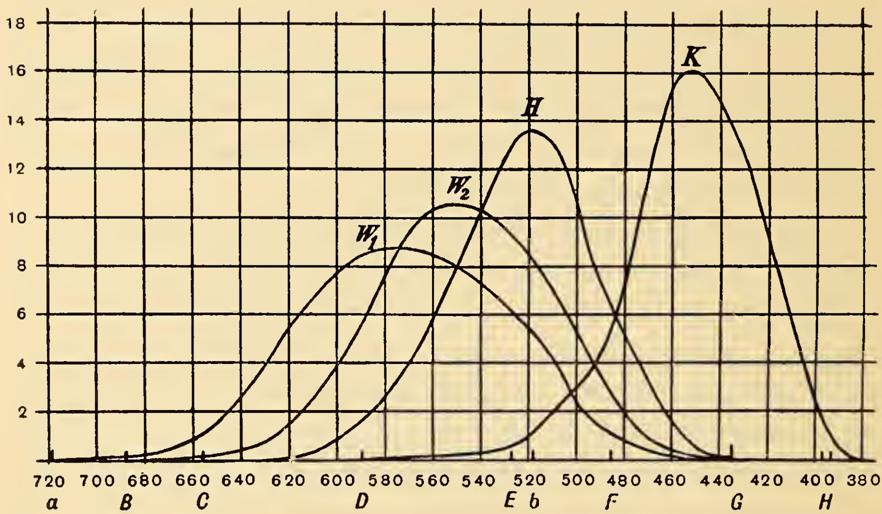


FIG. 50.—Curves showing chromatic matches for the red and green blind (from Parsons after Koenig). W_2 and W_1 are the curves for red for the red-blind and the green-blind, respectively. K is the blue curve for both. The curve H need not concern us. The figure is described further in the text.

Twilight Vision.—So far in our account we have considered the phenomena of vision only under daylight stimulation. Twilight vision, however, must be discussed, that is, vision in light of low intensity which is favored by dark-adapted eyes. When one passes from a light room to a dark room, one is at first unable to see, i.e., one is not at once *dark-adapted.* Later the difficulty clears up, and he becomes particularly sensitive to faint lights. The end-organs that become active are the rods in the retina—a fact that can be demonstrated on a dark

night by noting that a faint star becomes brighter if one looks just to the side of it. By this method retinal stimulation is shifted from the fovea where there are no rods to the adjoining rod-supplied regions. A light may be used which is actually invisible unless it stimulates the periphery of the eye.

One of the chief phenomena of twilight vision is the *Purkinje phenomenon.* In daylight vision, i.e., in light of good intensity, the yellow is the brightest hue of the spectrum. In twilight vision, on the other land, the brightest hue is toward the blue-green. This shift in brightness does not occur at the fovea, nor does it occur in totally color-blind individuals. For this reason it has been used to a certain extent as a test for color-vision in animals below man. It is also of interest to observe in connection with the sensitivity to faint light found in twilight vision that night birds, e.g., owls, have only rods in their retinae, while day birds, e.g., chicks, have only cones.

Theories of Visual Qualities.—The theories of visual qualities are attempts to construct the probable nature of the processes going on in the retina which underlie and condition the phenomena that we have been describing. The most prominent theories are those of Helmholtz and Hering. The former, although many times modified, is much less tenable than the latter. *Helmholtz's theory* assumes that the retina contains three substances called, after the color-qualities that they condition, the red, green, and violet substances. Light-waves stimulate all of these, but in unequal degrees. When all are stimulated in the proper proportion, an achromatic sensation results. This theory is at its best in the explanation of color-mixture, inasmuch as a proper combination of red, green, and blue will match all hues. Positive after-images are regarded as due to the inertia of the retinal substances. Thus, a certain after-image red is seen because, once the red substance is chemically affected by the light, it cannot stop at once when the stimulus is removed. Negative after-images are regarded as

due to unequal fatigue of the retinal substances. Thus, when yellow light affects the eye, the red and green substances which condition it are partly used up. Light now can affect only the violet substance, giving a blue which is the after-image. The theory fails to account for color-blindness, for peripheral vision, and for the perception of color at low intensity as gray. Its great defect lies, therefore, in the absence of a special mechanism for the explanation of the achromatic series.

This is remedied in the Hering theory as modified by Mueller and von Kries. This theory is the most widely accepted one today, its chief rival among American psychologists being the Ladd-Franklin theory.[1] Hering's theory assumes in the retina three substances: black-white, red-green, and blue-yellow. Of these the black-white, which is the most sensitive and the most widely distributed, is affected by all waves of light and is found both in the rods and in the cones. The color-substances, however, are found only in the cones and respond only to homogeneous light-waves. Each of the three substances has two antagonistic modes of activity underlying the two qualities specified in the name (black-white, e.g.). Color-mixture is explained on the same principle as in the Helmholtz theory, viz., by the stimulation simultaneously or in rapid succession of two or more color-substances in the same retinal area. Complementary color-mixture is explained as follows: If the red phase and the green phase of the red-green substance are stimulated with a certain relative intensity, the two antagonistic

[1] This theory, proposed by Mrs. Ladd-Franklin, lays particular stress upon the hypothetical origin of the color-substances. Black-white was the first substance to appear in the development of the eye and still dominates the periphery of the retina. The blue-yellow substance was the next to appear, and is found better developed in the middle color-zone than is red or green. The last substance (red-green) developed from the yellow substance. The theory makes possible several valuable interpretations in qualitative vision, but it is neither widely enough accepted nor of sufficient historical merit to justify an extended discussion here.

processes balance each other and consequently fail to give rise to any color-sensation. The light, however, still affects the black-white substance, and the result is a gray. The difficulty comes in the case of the black-white substance itself. Why does not a proper combination of the antagonistic processes in this substance result in a cancellation of all gray visual quality in place of resulting in a medium gray? To meet this objection Mueller has advanced the hypothesis that in addition to the gray of the black-white substance in the retina there is a "cortical" gray, conditioned by central (cortical) processes, which is active and becomes prominent when the black-white processes cancel. This hypothesis, however, is too much at variance with the current tendencies in sensory theories to warrant its acceptance as yet. It is perhaps best to regard the black-white substance as unique among retinal substances with respect to this particular point. On the Hering theory color-blindness is explained as an absence of certain color-substances. Peripheral vision is based upon the fact of the varying distribution of the visual substances in the retina. Twilight vision is a matter of the lower sensitivity of the black-white substance found in the rods; thus a light too faint to affect the color-substance may still arouse an achromatic sensation. Positive after-images represent an inertia of the chemical activity, negative after-images being due to the tendency of the visual substances to maintain an equilibrium between the antagonistic processes. Accordingly, if the red process is stimulated, the green is thrown into activity before equilibrium is again attained. Simultaneous contrast is inadequately explained by all theories, Hering assuming that the activity of one process in one part of the retina arouses an activity in the antagonistic process in immediately contiguous retinal areas.

Specific Nervous Energy.—We turn now from the consideration of individual sense-fields to a brief study of two general phenomena of sensory processes referred to as the

problem of *specific nervous energy* and the problem of *sensation intensities.* We shall consider the topics in the order named above. Why does the stimulation of the eye give rise to a conscious quality different from that conditioned by the ear? It cannot be entirely due to the fact that vision is aroused by light-waves and sound by air-waves, for both senses become active when stimulated by blows on the head and by the electric current. In the same manner, one fails to explain the differences between other sensory qualities on the basis of differences in stimuli because of this relative indifference of the stimuli-producing sensory qualities (thus, blows on the body may produce sound, pain, light, and pressure). To explain the phenomenon, Johannes Mueller (1834) proposed the hypothesis that each nerve has a specific energy which will produce its own quality and no other. Later workers have extended the theory to include the ascription of different energies to the same sense-field in order to account for qualitative differences within a single sense. Experimental technique, however, is unable to discover differences in nervous impulses. Those from the eye are to all intents and purposes exactly like those from the ear, and all impulses from each receptor appear identical. Present theories, as we have seen in the case of vision and hearing, explain the appearance in consciousness of sensory qualities in terms of processes going on in the receptors. Inasmuch, however, as consciousness only arises from brain activities, these differences in sense-organ activities must be carried over the nerves and into the brain. Accordingly there must undoubtedly be differences in nervous impulses. Perhaps some time in the future it may be possible to detect these differences experimentally, but at present it is impossible to get at the essential changes even in the sense-organs save by theory. It nevertheless seems most plausible to place the essential physical conditions of sensory qualities in the receptors partly because of their highly complicated structure (which we assume must

have a function) and partly because it is known that if the receptor is lost early in life the individual loses all imagery from this field. Visual imagery, for example, is absent in an individual whose sight is lost early in childhood. It would seem, therefore, that the specific physical process is initially dependent upon sense-organ activity, and then becomes supplemented by changes in the cortex. After this supplementation occurs, the loss of the sense-organ does not deprive the individual of all states of consciousness connected with that sensory field; he still retains images and memories. The question of specific nervous energy is the problem of the exact neural equivalent of sensory qualities. Even more, it is in the last analysis a concrete formulation of the question of the relation of mind and body, i.e., of what goes on in the body when a given quality of consciousness exists.

Sensation Intensities, Weber's Law.—We have been concerned up to this point largely with the important problem of sensory qualities. Sensation intensities have only been mentioned in so far as they affect qualities, e.g., in the question of twilight vision, but the topic of intensities is important in itself. As a matter of historical fact Ernst Weber in 1854 started the science of psychology with investigations of this question. The form in which the earlier workers put the problem is still with us: What is the relation between the intensity of the stimulus and the intensity of the sensation, and how does the latter change as the former increases? Weber's original work was upon the relation between the increase in intensity of pressure from lifted weights and the increase in the magnitude of the weights themselves. He found that the *stimulus must be increased by a certain constant ratio in order that the sensation might be just noticeably more intense each time.* With lifted weights Weber determined the ratio as 1/40. This means that no addition to a weight of 40 ounces will be noticed unless it at least equals 1 ounce, while to 40 pounds 1 pound must be added. The

law so stated has been found true for all the middle range of sensation intensities belonging to the following classes: light, noise, tone, pressure, kinaesthesis, and smell. The ratio in light is 1/100; in tone, 1/8; in noise, 1/3; in pressure, 1/30; and in smell, about 1/3. Each of these ratios is an average based upon a large number of observations and admits of considerable variation. Upon these experimental results we may formulate the fact that a slight difference in a small object is as readily noticed as a great difference is in a large object, the problem involved being that of the *differential threshold for intensity*. For studies of behavior, as opposed to studies of conscious processes, the phenomenon of Weber's law is important in pointing out the least differences between stimulus intensities that can afford a basis for two different responses. In the case of a rat, for example, if a light x is chosen on the basis of its greater intensity when compared with y, how much must the intensity of y be increased before the animal fails to make the distinction between x and y?

Following Weber, Fechner performed many similar experiments in other sense-fields, and finally formulated the law in mathematical terms that need not concern us here. The theoretical problem growing out of the phenomena of Weber's law involves the explanation of the loss in energy between stimulus and sensation. Fechner regarded the relationship as a mathematical one showing the ultimate relationship of mind and body. For this reason he termed the topic *psychophysics*. Ebbinghaus and Mueller interpret the loss of energy as an instance of increased resistance of the nervous system to the transmission of impulses resulting from increased intensity of stimulation. Ebbinghaus would place the major portion of this resistance in the cortex. The fact of prime importance for us to remember, however, is that the awareness of sensation intensities is a relative matter limited in each sensory field by a definite ratio.

The Awareness of Space.—Passing from the study of sensation qualities and intensities, we come to a consideration of two additional attributes of sensation, location and extension, the data on which constitute the psychology of space. The topic is one of great importance and of voluminous literature. We can only indicate here a few of the most fundamental problems and the general trend of the data bearing upon them. Common sense and some philosophy lead one to believe that the world outside of consciousness exists in spatial form. We have a very complex and highly elaborated conception of space which we term geometrical or mathematical. This we assume to be a fair copy of physical space. In this mathematical space, for instance, parallel lines never meet and things equal to the same thing are equal to each other. However, these axioms do not apply to space as we are immediately aware of it. When we compare this fact with the teaching of mathematics, we term the psychological fact an illusion, but it still remains a fact of experience. If a compass with points one inch apart is moved from cheek to cheek with the points on each side of the mouth, the lines diverge as the points pass the lips. Not only the first but also the second axiom mentioned above is inapplicable to conscious space due to the differential threshold. We may illustrate in this manner: Light *A* (100 c.p.) looks equal to light *B* (100.5 c.p.). Light *B* looks equal to *C* (101 c.p.); but *A* looks less than *C*, not equal to it, because the differential threshold for light intensity (1/100) has been passed.

The space of immediate awareness owes its peculiarities to the limitations in the structure and function of the receptors. These, as we saw earlier in our classification of the senses, adjust the organism to the space-characteristics of the stimuli as well as to the variations in vibration-rate and amplitude, or to quality and intensity. The space that is built up from these sensory data is grounded upon the so-called space-senses, vision and touch, which are adapted to stimuli that do not bend—

vision as a distance receptor and touch as a contact receptor. This condition, coupled with the fact that each receptor group has an *extended receiving surface* (retina and skin), is at the basis of their fundamental significance for space-perception. The cochlear canal and the olfactory membrane are also extended in space; but the stimuli which affect them bend and consequently are not adapted to the space-characteristics of objects. All sensations, as well as all states of consciousness in general, are located more or less definitely within the visual-tactual space-world.

Only vision and touch experiences, however, are intrinsically extended. The extension present in other sensations is an extension borrowed from these two. Low-pitched tones seem larger, more voluminous, more extended, than higher tones. It is probable, however, that this is due to an association established between certain pitches and the sizes of the object producing them. The fall of a tree makes a more voluminous sound in this sense than the fall of a cane. In addition many voluminous sounds actually jar the body, aiding in the impression of bigness through added associations.

The chief topics in the study of space-characteristics are as follows: Under extension come the three problems of size, form, and distance in the third dimension. In addition we have the question of the accuracy of location and the problems of movement, or change of location. In each case a detailed consideration must include a study of the development of the various abilities during the individual's lifetime, a study of the nature of the sense-organs involved, and a study of the variations in the various abilities at different parts of the body and under various conditions of fatigue, disease, etc. In the account that follows we shall comment upon one or two topics in each of the three fields most thoroughly studied—touch, hearing, and vision.

Tactual Space.—One of the fundamental problems in tactual space is that of the localization of a touch-sensation (1) with

reference to another touch and (2) with reference to a visual sensation. The first phase of the question may be stated as follows: If a given point on an individual's hand is touched while he is blindfolded, how accurately can he then touch the same spot; or how far apart must two compass points be before they are sensed as two? The second phase brings out much the same phenomena and is tested by having the subject indicate on a model of the arm the location touched. The whole question may be styled the problem of the *two-point threshold.*

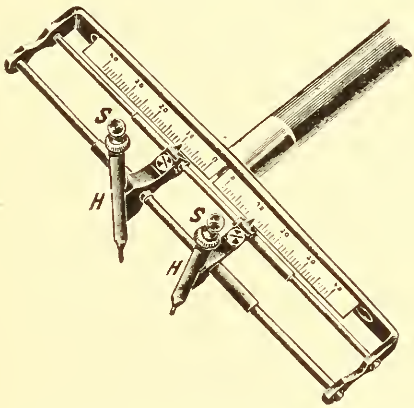


Fig. 51.—An aesthesiometer

When the compass points are used, the apparatus is an aesthesiometer (Fig. 51), and the two points may be applied simultaneously. The procedure consists in applying the points quite widely separated at first and then closer and closer together until the subject gives the judgment "one." Then the experimenter starts with a separation a little less than this and gradually increases the distance of the pointers until the subject responds with "two." The average of a large number of descending and ascending judgments is termed the two-point threshold. Care must be taken that the compass tips are poor conductors of heat (hard rubber is usually used) or temperature-sensations serve to disturb the test. As the compass points

approach each other in the descending series, the distinct awareness of "two-ness" finally gives place to a dumb-bell-shaped contact which, as the points are further approximated, gradually changes to the awareness of a point. Practice enables the individual to interpret these changes and consequently to decrease his threshold—i.e., to increase his apparent sensitivity to location differences.

Weber found that the threshold was least on the tip of the tongue and greatest in the middle of the back and on the upper arm and leg. A few of his measurements are here given:

Tip of tongue	1 mm.
Red of lips	5 mm.
Cheek	11 mm.
Back of first phalanx of finger	16 mm.
Back of hand	31 mm.
Middle of back	68 mm.

He also found that localization was more accurate on the arms and legs in a transverse than in a longitudinal direction. Furthermore with successive stimulation the threshold is lower. Judd found that each pressure-spot could be distinguished unless the spots were so close that individual stimulation was impossible.

In explanation of localization Lotze proposed that each pressure be regarded as having a peculiar *quale* called its *local sign* by virtue of which it could be assigned to a distinct part of the body. The two-point threshold would therefore be the limit of difference between local signs. Bernstein and von Frey suggest that each stimulation produces an irradiation in the skin[1] and that where the two irradiations overlap greatly a sensation of "one-ness" results. The facts are not yet available which will permit a decision between the theories.

Auditory Space.—Here again, in order to illustrate the topic, we are to deal with the question of accuracy of localization.

[1] Bernstein thought of it as in the nervous system.

Our discussion may be brief. The apparatus usually employed is termed a sound-cage and enables one to present a sound in

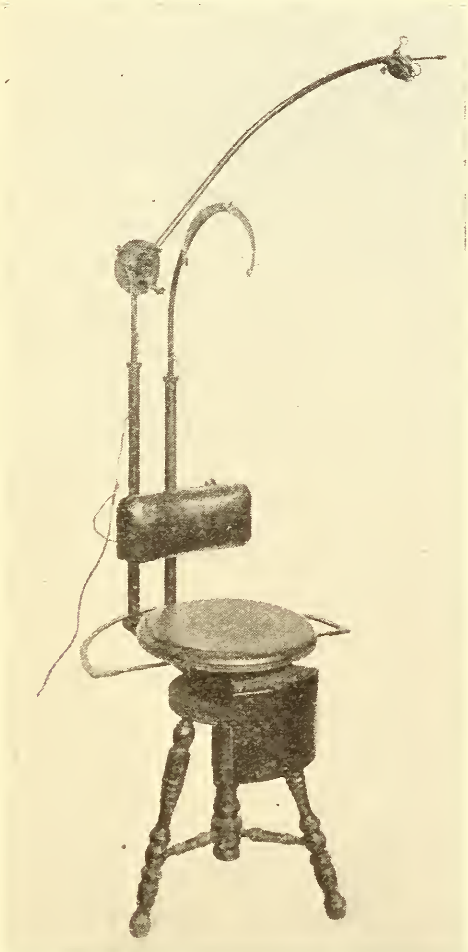


FIG. 52.—A sound-cage. The upright bar which carries an iron arc with a telephone receiver on it can be rotated about the subject seated on the stool. The telephone receiver can be varied in location anywhere in a sphere surrounding the subject's head.

any direction from the subject who is seated within it (see Fig. 52). Localization is most accurate between the region opposite each ear and the median plane of the body, but when

a sound is given in this median plane it is difficult for the subject to say whether it comes from in front or from behind. The sound-waves in this case stimulate the two ears with practically equal intensities. In the part of space lying immediately about the axis running through the two ears sounds are accurately localized as being on one side or the other of the body, but changes must be of several degrees before a change in the localization of the sound is observed.

As we have just suggested, the relative intensity of the sound to the two ears is a fundamental fact in the appreciation of sound direction. Angell and Fite have shown, furthermore, that tonal complexity is an aid in sound localization, for pure tones cannot be accurately located in space. When the air-waves conditioning a complex tone stimulate the two ears, the more distant ear fails to receive many of the high overtones due to the sound-shadow produced by the head. Such changes in the timbre of the klang facilitate accurate space-discrimination. Other factors have also been proposed as aids in localization, but they do not merit discussion here.

Visual Space.—Not only does vision give the most accurate information concerning the lateral extension of objects, but it is also the only distance-sense that gives more than a rough approximation of distance or extension in the third dimension. It is of peculiar importance to the individual in adjusting himself to his environment to secure information upon this point. A part of the awareness of depth is truly visual, i.e., is dependent upon peculiarities of retinal stimulation. Much, however, is based upon kinaesthetic nervous impulses coming from the ciliary muscle and from the six extrinsic muscles of the eye, that is, from impulses aroused by accommodation and convergence.

The chief visual characteristic which determines distance is that of binocular disparity. If one fixates an object with both eyes, it can be readily demonstrated by closing first one eye

and then the other that the two eyes are stimulated by different aspects of the stimulus. The fusion of these two disparate retinal stimulations gives the perception of depth, or stereoscopic vision. It is this fact that makes objects appear solid and not flat. Whenever the eyes fixate a given point, there is a series of points in space that are focused accurately on the retina and that are therefore seen clearly. These points constitute the *horopter*. When the eyes fixate an object near by, the horopter is essentially a circle passing through the two eyes, the fixation point, and a line perpendicular to the circle through the fixation point. All points not included in this horopter are seen doubled. Those that lie nearer than the fixation point are reversed so that the right eye sees the left point and vice versa. Those lying farther than the fixation point are not reversed. The points included in the horopter stimulate corresponding points on the two retinas, while all other points fall upon non-corresponding points. These variations in retinal stimulations, however, come to consciousness only upon reflective analysis of the type we have used here, for the neural processes ordinarily fuse below the threshold of consciousness. We are aware of them, then, only as the awareness of solidity and depth.

The nervous connections that condition the fusion of disparate retinal stimulations are quite probably inherited. There are other visual cues in depth-perception, however, that are acquired by experience. The interposition of one object between the eye and another object indicates that the latter is farther away. Hazy objects are also usually judged as distant. The sizes of known objects afford other cues, e.g., an object that is recognized as a man, if very small, is judged far away. The estimation of distance at sea is rendered difficult largely because of the absence of familiar objects upon which to base judgment.

The two remaining important cues used in depth-perception are convergence and accommodation. When a near object is fixated, the two eyes converge more than for the observation

of a more distant point. This variable intensity of muscular contraction can therefore serve as a cue for nearness and remoteness. It functions primarily with a binocular perception of depth. In accommodation the sensory impulses come from the ciliary muscle in which increased contractions occur with increased nearness of the object. The mechanism of change in the shape of the lens is shown in Fig. 53. The contractions loosen the suspensory ligament holding the lens, and the latter bulges out in thicker form by virtue of its own elasticity (Helmholtz). It is practically impossible to separate the two factors and assign one (convergence) to binocular vision and the other

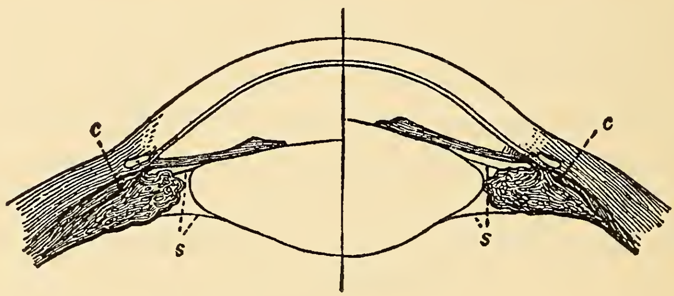


Fig. 53.—Variation in shape of lens during accommodation; *s*, suspensory ligament; *c*, ciliary muscle.

(accommodation) to monocular vision. Even with one eye closed, that eye continues to move in harmony with the open one and so continues to produce the normal convergence impulses. It is pretty generally agreed that the kinaesthetic data contributed from these two processes, although they are of value, nevertheless do not make accurate judgments possible. The judgments of depth made in monocular vision are based largely upon the secondary retinal criteria stated above.

Functions of Sensory Processes.—It is obviously difficult to generalize the functions of the many sensory processes that have been studied in the preceding chapters. As usual the question must be approached from the standpoint of conscious-

ness as well as from that of behavior. From the former angle the chief function of sensation lies in constituting the fundamental stuff of consciousness, a condition that was made clear in our earlier study of emotion and affection. This statement stresses sensory qualities. Intensities, meanings, locations, so far as they are connected with images, however, may be likewise traced back to original sensory attributes. The only exception is the possible one of affective qualities, for most psychologists believe that these deserve a place with sensations as the original stuff of consciousness. In the following accounts of imagination, memory, and thought, the fundamental place of sensory material will be further appreciated. From the behavior side we must speak of the function of receptors and sensory impulses. Receptors function as the most sensitive receiving structures in the body. They are the immediate go-between for the environmental changes and the organic responses. Their detailed function has been discussed in connection with "Attention" (p. 115) and with the "Classification of Sensations" (pp. 221 ff.). Sensory nervous impulses have their function in arousing the activity in the effectors which constitutes the behavior of the organism. Overt behavior may be long delayed and may even never appear as a recognized response to the earlier sense-organ stimulation. I may see a painting or hear a symphony and never have my conduct modified in such a fashion that the modification can be traced back to the influence of these events. Nevertheless, immediate bodily responses have occurred at the time of the stimulation, perhaps in the form of emotional disturbances or perhaps only in the form of the motor accompaniments of attention.

One need not attempt to decide which functions are the more important, those from the standpoint of behavior or those from the point of view of consciousness. The problem must be approached from both angles if a true perspective is to be secured.

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CHAPTER VIII

IMAGINATION AND THE SEQUENCE OF EXPERIENCES

I. IMAGINATION

The Image and Sensation.—If an air-wave of 256 vibrations per second stimulates my ear and finally arouses a nervous activity in the temporal lobe of the brain, the resulting state of consciousness is a sensation—in this case an auditory sensation. With another stimulus and another receptor the sensation might have been one of pressure, taste, or vision. We have defined these conscious states as the awareness of objects as present to sense. If, however, I am aware of sound, taste, or visual objects when the corresponding receptors are not stimulated in such a way as to arouse these states of consciousness, I am experiencing an *image*. In this case the nervous activity in the temporal lobe, if the image is an auditory one, is aroused, not directly from some sense-organ, but from some other area in the cortex. This is called central arousal. Sensations are peripherally aroused, i.e., the nervous impulses which condition them reach the cortical center without first passing through other cortical centers.

By an image is meant the consciousness of an object as not present to sense. With sensory processes we found a belief in, or acceptance of, the physical presence of the object. In imaginal processes there is belief in the physical absence of the object. The lack of this feeling of reality with images is to be accounted for on the basis of the following differences between them and sensations: (1) Images are usually less intense than sensations. (2) They are also usually less stable, i.e., they fluctuate and come and go in a way that sensations do not unless they are very near the limen of sensitivity. (3) Images

usually contain less detail. If the sensation is of red, the image will also be red—and may be of the same shade—but the outline is likely to be less clear. If the sensory process is a perception of a chair, the image again will not usually contain as much of the detail as can be seen or felt. A part of this deficiency in detail in imagery is probably due to the lack of stability which we mentioned above. (4) Imaginal objects cannot be verified by the other senses. If I perceive an object visually, I am usually able to go over and touch it or lift it, thus convincing myself that the object is actually present. When, however, I have a visual image of the object, it is impossible to touch, lift, or hear it. Because of these four differences, we find but few instances in which we have difficulty in judging whether we are experiencing a sensation or an image. These are usually cases of sensations near the threshold of sensitivity.

Images, like sensations, have all the general attributes of consciousness in varying degree. The belief, that is peculiar to the image, in the physical absence of the object is a meaning ascribed to it. It may also have other meanings limited as to kind only by the nature of one's past experience. Thus a certain round image may mean the moon, an apple, a golf ball, or anything else with which it may have been associated in the past. In respect to intensity, however, it has sometimes been claimed that images lack this attribute (Ebbinghaus) and that the auditory image of a peal of thunder is no more intense than the auditory image of a whisper. Images that are aroused shortly after the original sensory processes do differ in intensity, but, as they increase in age, it is true that differences in intensity are largely overcome until all images may become alike in this respect. Concerning the other general attributes of consciousness possessed by images, i.e., duration, clearness, location, etc., no particular comments are required. It is important here merely to emphasize the fact that images are not necessarily localized within the head. My image, for example, of Camp

Lee, Virginia, lies in front of me and contains barrack buildings of a size to lead me to say that they were one-fourth of a mile away. It is the low intensity and poor stability of the image which leads the popular observer to overlook the fact of the frequent external localization of images.

The Neural Basis of Imagery.—We have already commented upon the fact that images are centrally aroused while sensations are peripherally aroused. That is one very important characteristic of the neural action underlying imagery. Attention must now be called to the fact that the neural basis of image *quality* is undoubtedly the same as that of its corresponding sensation. There is no good reason for saying, granted that cortical activity X is the basis of the quality red set up by stimulation of the eye, i.e., in sensation, that any other cortical activity Y is necessary when the quality red is in consciousness as an image. There must usually be a difference in the nervous processes conditioning intensity, duration, and stability, because these characteristics are different in sensation and imagery. The chief neural difference, aside from that of central versus peripheral arousal, comes in the associated neural processes that give meaning to the experiences. In sensation the meaning is "present to sense"; in imagination the meaning is "not present to sense."

Image-Types.—Not all sensory processes, let it be said, are equally susceptible to central arousal. It is difficult to secure images of taste, smell, organic, and kinaesthetic experiences. Visual and auditory images are the most common, with cutaneous and kinaesthetic ones probably holding a middle place. The pioneer study of this question of the distribution of mental imagery was made by Francis Galton (1883). Galton submitted a questionnaire to his scientific friends which requested them to describe in detail the image they retained of their morning's breakfast table in regard to color, illumination, definiteness of outline, etc. Much individual variation was found, many even

denying that they possessed visual imagery. Later tests were made upon imagery from the other senses and equally variable results were secured.

Images, as the above paragraph suggests, are usually classified on the basis of the sense-organ involved in the original sensation. Charcot has called our attention to the need of recognizing verbal imagery in addition to concrete imagery, i.e., images of words which may in their turn belong to any of the sensory classes. Thus one may have the image of a cow in the form of a printed word or as a word spoken. With individuals whose thinking concerns highly elaborated and abstract material (as is the case with most professional callings), the tendency is for verbal imagery to replace concrete imagery. This tendency is intelligible when it is recalled what a large place language plays in man's adjustments to his surroundings.

Working upon this preliminary basis, psychologists, notably Segal, Betts, Mabel Fernald, and James R. Angell, have canvassed very thoroughly the possibility of assigning individuals to certain image-types and of terming them visualizers, audiles, motiles (users of kinaesthetic images), and other types. In judging whether a given individual belongs to one class as opposed to another, account must be taken of the relative frequency, intensity, and accuracy of the two forms of imagery. Stated briefly, the result of the experimentation has been that nothing approximating rigid image-types exists, for centrally aroused consciousness is too profuse, complex, and plastic to be contained in such molds. Individuals may use a certain form of imagery at one time for a problem and another form at a later time for the same problem when it recurs. This means that if a problem is given a subject, he will report from time to time different kinds of imagery used in its solution. This method of studying image-type is termed subjective. Various objective methods have been proposed which seek to determine the nature of the subject's imagery in terms of his time- and

accuracy-record in the solution of memory-problems. One such test consists in comparing an individual's ability to memorize materials belonging to vision, audition, etc.; whereupon he is assigned to the image-type that corresponds with the sensory material in whose learning he excelled. These methods are unreliable save as they are checked up by the subject's own observation, for no objective methods can be trusted to show the presence and kind of consciousness.

Productive and Reproductive Images.—Descartes and Locke long ago made clear that no qualities exist in imaginal form which have not previously existed as sensations; that is, to use familiar words, sensation is the fundamental source of all knowledge and is one at least of the mental elements. Two forms of imaginal reinstatement of past experiences are recognized—reproductive and productive imagery. By the former term we mean imagery that duplicates the earlier experience. I see a house, or hear a melody, and later recall these experiences in imaginal form unmodified. This recall is closely related to memory, as we shall see later, and needs only an accompanying recognition of the experience to make it a state of memory-consciousness. Such imagery has the merits and limitations that always pertain to the literal; however, most imagery undoubtedly is of this type. Account, however, must be taken of many images that appear to be new and that resemble hardly at all any objects that one may have seen or heard. The musician has in mind an image of a new combination of notes which he puts into audible form. The scientist has in mind the image of a new process, a new method, or a new machine. He can then proceed to construct an object similar to his image, but prior to this there has been no sensory experience of such objects. These are cases of *creative* or *productive* imagery. In most cases these new images can be shown to be combinations of elements that have been experienced before. The first image of a bow and arrow, e.g., combined in a novel

way flexible wood, taut string, and slender projectile, with each of which primitive man was already acquainted. The strange creations of myth and current fancy—dragons, centaurs, sea-serpents—only combine in a novel way sensory experiences that are already familiar. The problem is probably correctly answered in this manner, but it could not, however, be so summarily dismissed if a comprehensive discussion were to be given. No less authorities than James and Bergson have championed the view that no conscious process ever returns as the same thing and that the world is essentially novel from moment to moment of time. These more speculative, but not therefore less valuable, questions must, however, be left for philosophy. Genius will always detect relationships and project ideals that elude the lesser man and accordingly seem to be essentially novel and creative, however much scientific analysis may show them to be but old and reproductive.

The Function of Images.—The functions that we shall ascribe to images are not peculiar to them, but are shared in common with those sensations that enter into sequences controlled by the organism (see p. 285). Images free the organism from a dependence upon present sensory stimulation.[1] By virtue of the possession of images I can react to objects which are not physically present—I can plan a house, sell stock, or re-experience an emotion of joy. With images I can build up a conception of the universe far surpassing what I can see, hear, and touch. The imaginary, however, is not the illusory and the unreal. Honor, virtue, character, and all ideals are things never present to sense; they are creations of imagination, but they are not unreal. Because of their central arousal they are usually less compelling than sensory stimulations. It becomes, therefore, more difficult to secure a reaction to a moral ideal (complex of images) than to the pangs of hunger, for example,

[1] We speak of this as a *function* of images merely for convenience. It is the underlying nervous activity that has the function here outlined.

but it is done. The Stoic and Epicurean philosophical systems are historically great instances where man has fallen back for consolation upon imaginal worlds when the world of sensory stimulations has broken down and become disorganized. Religion is a perennial refuge of this type.

The great freedom from dependence upon present sensory stimulation conferred by the possession of imagery is one great difference between man and other animals. He alone possesses in any marked degree the ability to respond to an absent series of stimuli. This is conspicuously shown in a comparison of self-preservation in man and other animals. An animal fights to keep its body intact, to ward off sensory pains, and to preserve sensory pleasures. Man fights to preserve a system of values. He does not fight for life, but for life of a certain kind. Life without honor is not worth preserving.[1]

> In the gates of Death rejoice,
> We see and hold the good,
> Bear witness earth, we have made our choice,
> For freedom's brotherhood.
>
> Then praise the Lord, Most High,
> Whose strength hath saved us whole,
> Who bade us choose that the flesh should die,
> And not the living soul.

As a corollary to the foregoing function of images is the fact that images enable the organism to adjust itself to the temporal order of natural events. One can recall the past and anticipate the future. In every instance, however, the conscious state is a present conscious state, although it may have a backward or a

[1] The situation can be stated more behavioristically and, as far as animals below man are concerned, more accurately in terms of nervous processes. The animal does not have the foregoing purpose in consciousness, but his nervous system in functioning secures that purpose. The nervous processes here are initiated in the sense-organ by present stimuli.

forward reference. A conscious state is said to have a backward reference when it is referred to past moments of time. This usually takes the form of *recognition*, a topic which we shall discuss in the chapter on "Memory." In cases of forward reference, the individual constructs the probable nature of future happenings upon the basis of past experience. It is probable that such a combination of past experiences means a future event by virtue of the expectant muscular attitude that the subject assumes while conscious of the combination.

II. THE SEQUENCE OF EXPERIENCES

The Sequence of Images and Sensations.—So far we have discussed only the individual image, its type, and function. One of the striking things about imagery, however, is the fact that image succeeds image in a more or less orderly manner. The image of the word "war" appears and suggests "Belgium"; that suggests the "entry of America into the war"; and so the train of images proceeds. This sequence is within the control of the individual to the extent that the images desired can usually be recalled. For the purpose of comparison our discussion of sensation needs to be amplified at this point. In sensations, which are aroused as we know by present stimuli affecting the receptors, there is also a sequence, or succession. Often this fact is due to a sequence of stimuli that lie outside of the organism's control; thus I pass along a certain avenue, and house after house, tree after tree, appears in consciousness. The succession of these perceptions is to be explained on the basis of a succession of stimuli to the eye. Inasmuch as the ether-waves constituting these stimuli are beyond my power to produce, if I desire the foregoing sequence of perceptions I must place myself before the stimuli. My control consists alone in my ability to do this. The sequence of images, however, is quite different, for I may secure a succession of them no matter where I may be, independent of my power to re-view

the objects. It is possible to have such a sequence of sensations or perceptions also, but rarely if ever in the case of vision. My walking or writing proceeds automatically and spontaneously, bringing into consciousness a sequence of kinaesthetic and cutaneous sensations; or I may swing my arms voluntarily with the same result. This case, it will be seen, is essentially of a kind with a sequence of images in that it may occur wherever I am. Auditory sensations and perceptions fall in a class with kinaesthetic processes, i.e., they can be controlled in a manner impossible with light. The muscular contractions of the voice-mechanism produce not only kinaesthetic sensations, but they also set the air in vibration and arouse, consequently, auditory sensations which may succeed each other in the form of cries, speech, song, etc. Over this sequence I possess a great control entirely out of the question in vision where light is the stimulus, for I carry around with me the capacity to secure this train of auditory sensations just as I do the capacity to secure a train of images. In a similar manner I may experience emotions and bodily thrills regardless of the absence of the original stimulus. Although kinaesthesis and sound are the most important instances of sensation sequence within the control of man, all of the sensory processes save vision share to some extent in the phenomenon. With certain animals, however, who carry light-producing organs, even visual stimulations are within the organism's direct control.

The Laws of Association.—The sequence of all these conscious processes—sensations, images, or emotions—is fundamentally determined by the factors discussed in the chapter on "Attention" under the title "Factors Conditioning Attention." One group of these determining conditions consists of the laws of association, concerning which it devolves upon us now to secure a thorough understanding. They were first formulated by Aristotle and came into prominence in modern times with David Hume, David Hartley, and James Mill. The primary

law of association is the *law of contiguity: If any two states of consciousness are experienced together in space and time and if later one of them reappears, the other tends to follow.* If I see a ball and a bat simultaneously (together in space) and if later I see the ball or have an image of it, I tend to think of the bat at once. If I think of it visually, the re-experiencing of it is in the form of an image. If I hear the words ball and bat in immediate succession (contiguity in time) and later have either an auditory perception or image of the word "ball," I tend to experience either an auditory perception or an auditory image of the bat. The second term of the association may be peripherally initiated in cases where, as we have seen above, the stimulus is within the organism's control. This is true in varying degree of all conscious processes save vision, being clearly the case with emotions and affective processes. If I see a savage dog and experience an emotion of fear, later when I see the dog or even imagine him I am certain in many cases to re-experience the emotion of fear, not in faint imaginal form but as an actually present bodily resonance. If I see a certain type of object it arouses horror or disgust or mere unpleasantness, and each of these emotional and affective conscious processes may be re-aroused bodily by an image of the original object. As we have pointed out in the preceding section, the majority of these sequences of peripherally initiated states of consciousness are kinaesthetic, auditory, or emotional in character. Psychologists since Aristotle have stated that the second term of an association must be an image (centrally aroused process); but this position we can clearly see is untenable, for the second term may be any conscious process whose stimulus is within the organism's control.

The Neural Basis of Association.—The principle underlying association is that of habit-formation, or the setting of synaptic connections in the nervous system. Instincts, for example, are cases of inherited associations of reflex arcs, and

they can be modified during the life of the individual by further acquired associations. These later modifications are examples of the conditioned reflex discussed on page 16. Although the law of association has its historic place as a law of consciousness which Hume has likened to the law of gravity in the natural world, association cannot be regarded as a force that binds mental states together. These latter follow each other in a definite way because neural processes follow each other in a certain way and not because they are bound together by mental ties.

If we were to diagram the probable neural basis of a typical associated series of conscious states, the result would be similar to that indicated in Fig. 32. When I see an object, secure kinaesthetic sensations of trembling, and experience contact sensations from having touched the object, the nervous impulses shuttle back and forth between the brain and the periphery of the body. They are not confined to the brain itself. From the standpoint of the nervous system an association is a connection between centers such that when one is active the nervous impulses tend most readily to arouse activity in the other.

Secondary Laws of Association.—Secondary laws of association have been formulated to supplement the primary law of contiguity and to account for the selective action of association. The law of contiguity explains why some conscious states follow others, but it does not account for the fact that a particular conscious state and not some other appears. Both fire and classwork, for example, are associated in my experience with whistles. Why do I at one time think of fire when I hear a whistle, and at another think of classwork? It is to explain this type of case that the secondary laws have been formulated.

These secondary laws of association are *frequency*, *recency*, *vividness*, *primacy*, *emotional congruity*, *similarity*, and *cause and effect*. Each of these points out some condition by virtue of which X follows Y, although experiences A, B, C, and D have

also been associated with Y in the past. When I hear the word "war" I may think or speak the word "Belgium" by reason of the fact that the two have been frequently and vividly conjoined in consciousness, or because Belgium was the first thing (primacy) connected with the war. After the word "Belgium" comes "deportation" by virtue of the recency of the association. "Deportation" is followed in consciousness by the word "slave" (cause and effect), and "slave" at once suggests "American slaves" by similarity. All of these associated terms have the same depressing emotional tone, i.e., they are *emotionally congruous*. The reader will do well to trace out other associated trains of conscious states in order to convince himself of the importance of the laws just stated.

We should be clear in connection with these secondary laws, as we were with the primary law, that we are not dealing with psychic (mental) forces. The secondary laws designate, in the first place, conditions that favor the continued re-excitation of nervous processes. If a nervous pathway is frequently traversed, its resistance is decreased so that the nervous impulses pass over it more and more readily. If a pathway has been recently used, it is in a highly permeable condition for a certain period of time, thus favoring the repassing of impulses along it. *Primacy* refers to the first neural connection made. Common opinion testifies to the ready recall to mind of first loves, first dances, first days in the army, first battles. First neural associations are evidently important. *Vividness* refers to the influence upon the fixing of neural connections of the bodily processes underlying emotional and affective experiences. In some way the nervous processes underlying these vivid conscious states serve to aid certain neural processes and to inhibit others. We have met the fact constantly, first in the account of psychoanalysis and again in the account of emotions and affections. Thus if I see a wreck, hear a name, and experience horror at the same time, the total event is indelibly fixed in the

nervous system because of the emotional element, so that later on the experience persistently bobs up in consciousness. By *emotional congruity* we refer to the fact that all ideas that we are conscious of at any one time share the same emotional tone. Thus when our mood is predominately sad, melancholy thoughts dominate us; but when we are happy, depressing ideas have no chance to enter consciousness. In emotional congruity we must assume that the presence of an organic disturbance (the emotion) facilitates the arousal of the various neural activities that have been associated with it in the past. The result in consciousness is that only congruous ideas tend to appear so long as the particular organic disturbance lasts. It is probable that the law of *cause and effect* designates only a certain regular form of contiguity and so involves no new statement of neural relationships. "Matches," for instance, lead us to think of "fire," not because one is the product of the other, but because fire is an almost invariable accompaniment of matches. The law of *similarity* can best be stated in terms of nervous processes as follows: If a nervous process *abcd* is active, it tends to be followed by activity *cdef*, because of the activity of the common elements *c* and *d*. Thus, on the conscious side, I see a lamp that suggests the image or the auditory-verbal perception "tree" because of a similarity in form, for a common nervous activity underlies the meaning "spreading top."

In the second place, the secondary laws of association designate relationships between conscious states. From this relationship it has been possible to make a probable construction of the neural activities that underlie them. When the sequence "war," "Belgium," etc., has once appeared in consciousness, it is possible by comparing the individual terms to detect relations of recency, frequency, similarity, etc. These relationships do not precede the terms and accordingly call them forth; they appear after the terms are in consciousness. The causal factors lie, as we have indicated, in the nervous system.

Total and Focalized Recall.—James and Calkins have emphasized the practical importance of the two types of association termed *total*, or *concrete*, and *focalized*, or *partial*, *recall.* If one were to refer to persons on the basis of the character of the sequences of conscious states usually present, one would speak of *literal* and *clever* people. In the first case there is a mechanical succession of conscious state upon conscious state with practically the whole of the first influential in recalling the second. Such an association is represented well by the sequence of letters of the alphabet, *a*, *b*, *c*, *d*, etc., where the appearance of one calls forth the next. It also appears in those reports of events given by persons who enumerate point after point without evaluation. The garrulous man and the child of eight belong here, for their conscious sequences are prone to be founded upon the relatively superficial. This is beautifully illustrated in a passage quoted by James from Jane Austen's *Emma:*[1]

"But where could *you* hear it?" cried Miss Bates. "Where could you possibly hear it, Mr. Knightley? For it is not five minutes since I received Mrs. Cole's note—no, it cannot be more than five—or at least ten—for I had got my bonnet and spencer on, just ready to come out—I was only gone down to speak to Patty again about the pork—Jane was standing in the passage—were not you, Jane?—for my mother was so afraid that we had not any salting-pan large enough. So I said I would go down and see, and Jane said: 'Shall I go down instead? for I think you have a little cold, and Patty has been washing the kitchen.' 'Oh, my dear,' said I—well and just then came the note. A Miss Hawkins—that's all I know—a Miss Hawkins, of Bath. But, Mr. Knightley, how could you possibly have heard it? for the very moment Mr. Cole told Mrs. Cole of it, she sat down and wrote to me. A Miss Hawkins—"

Opposed to this type of association is the case of Newton's having the action of the earth suggested by a falling apple. This and fortunately most other cases of association are

[1] William James, *Op. cit.*, I, 571. New York: 1890.

instances where one particular aspect of a given conscious state is related to the succeeding conscious state—cases of focalized associations. In an earlier example the study-lamp suggested trees by virtue of one characteristic, its form. On the neural side this is described as we have already stated in our account of association by similarity. The importance of the ability to think in this manner rather than in that of Miss Bates can readily be appreciated.

Simultaneous Association.—So far we have discussed association from the standpoint of the sequence of conscious states and the sequence of muscular responses (habits and instincts). There is also a simultaneous association both in the field of consciousness and in the accompanying field of behavior. I see an ink-bottle upon a table, or hear two tones sounding together. Later when I recall the bottle in consciousness it is recalled with the table upon which it still sits. Likewise the recall of one tone brings simultaneously its accompaniment. These simultaneous experiences are held together as conscious objects by the contiguity of nervous processes—a principle which is at work uniting the elemental parts of all objects of imagination, i.e., all centrally aroused conscious states. The main exception is where the simultaneity of parts is due to present stimulation by objects (light, sound, etc.) not produced directly by muscular or glandular activity. When, for example, I see a table, the top and legs are together because the light-waves so stimulate my eye and not because of association. In a similar manner when I touch a round, rough object, the roundness and roughness (touch-kinaesthetic perception) are held together in consciousness by the external stimulus acting on the receptors. There are, however, many peripherally initiated processes (sensations and perceptions) that are held together by virtue of the associated action of nervous processes. Trembling is a cutaneous-kinaesthetic perception, the two elements of which result from inherited connections in the nervous system.

This is likewise true of all the complex conscious experiences which at any one moment accompany instinctive responses. Instincts, as we have seen, are co-ordinations of reflexes. One does not have, however, a single muscular or glandular action in fear succeeded by another, but one has many muscular and glandular activities at one moment succeeded by another complex response at the next moment. The co-ordination or association is fixed by heredity, not only between successive moments, but also between the elements composing any one moment.

Where the muscular responses are acquired and are therefore habits, the same general statement holds. I sing a certain tone, or laugh a certain laugh. The simple tones and noises that make up these sounds are held together by virtue of the air-waves that stimulate my ear, it is true, but these air-waves are what they are by virtue of the acquired connections in the nervous system that make the special muscular contractions possible. These are the cases in simultaneous association that parallel the sensory and emotional sequences of successive association.

Both types of association are constantly at work. One does not find first one and then the other. Conscious states as they occur are held together as units in cross-section (simultaneously) as well as in longitudinal section (successively). Our chief concern has been with the latter case. In extending the present account the most important comments will be made under the headings of "Memory" and "Thinking."

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CHAPTER IX

MEMORY

Definition.—The term memory can be used in either of two ways. It may be used to apply to the general fact of the *retention of the effects of past experience*, or it may be restricted to a *state of consciousness which I am aware of having experienced before.* In the first sense the term memory is a characteristic of all matter. A stone that is chipped retains the scar. A wire that is bent once or twice is more easily bent the third time by reason of its other experiences. Likewise, pathways in the nervous system that are once active are more readily traversed by later nervous impulses; that is, we say their resistance is decreased. Retention, accordingly, is a purely physiological affair. Sensations of color, tone, touch, etc., are not stored up in memory as in a closet, for they do not exist at all after the stimulation ceases. During the period of retention the individual is unaware of "memories," the thing that does remain being the changed condition of the nervous system. When the particular nervous activity underlying the previous sensation is re-aroused, the sensation appears again, and if it is now *recognized as a thing previously experienced*, the case is one of *memory consciousness.* For example, I play the tone C on the violin. When the string ceases to vibrate the tone is non-existent. It is not stored up in some world of tone. In order to call forth the tone the violin must again be played. When I speak of forgetting, I refer either to the absence of a certain state of consciousness or to the absence of a certain nervous activity. To be forgotten, as we shall see, does not mean that no traces are retained in the nervous system, for it is probable that no retention is ever completely lost. For-

getting, therefore, is not the opposite of memory. Any state of consciousness that is not now present is forgotten; but only those present states of consciousness that are recognized are moments of memory consciousness. Retention, therefore, is clearly a fundamental characteristic of nervous action, underlying every phenomenon of behavior and of consciousness. Even instincts and reflexes, as we have seen, are retentions of inherited modifications of the nerve tissue. *Plasticity* should be placed beside retention as the other conspicuous attribute of nervous action underlying memory and all other conscious processes, for in order to retain it is first necessary that the nervous system be modifiable, or plastic, since it is the modification that is retained. Our discussion of these two topics will be in terms of *learning*, or *habit-formation.*

Memory and Imagination.—Memory, according to our second definition, is *any state of consciousness plus recognition.* Since we shall study the nature of recognition in detail in the following section, it will suffice to describe it here as the attribute of familiarity, i.e., as the awareness of having experienced the object before. Defined in this manner, memory is a much broader term than *imagination.* An image is a centrally aroused conscious process, while memory includes peripherally aroused processes as well as those centrally conditioned. Sensations, emotions, affective processes, images, and concepts may all alike be cases of memory if, and when, they are recognized. Popularly one tends to hold that memories are composed of images. I sit and call to mind "mental pictures and sounds" of the past. I indulge in reminiscence, and I recognize these images as revivals of my own past experience. I may, however, hum a melody (a series of auditory sensations) and recognize that it, too, belongs to my past; or an emotion of fear may re-present itself and be recognized, that is, be felt as *familiar.* The sensory qualities need not be aroused by association, as the above illustrations would tend to suggest. I may, for

example, be carried by train through a countryside visited years before. Object after object comes into consciousness with that "tang of familiarity" which constitutes it a moment of memory. Imagination involves an initial impression, a retention of nervous modification, and a recall, or better a reinstatement, of conscious material. If recognition is added, we have one case of memory. In addition, memory includes *all cases of reimpression that are familiar*, whether the reimpression is due to association or to the reappearance of stimuli because of conditions outside of the individual's control.

Recognition.—What is this characteristic of recognition which sets off memory consciousness from non-memory consciousness? The essence of it is *familiarity*, a complex of organic and kinaesthetic data that is usually markedly pleasant. Titchener has suggested that it may be a faint form of the emotion of relief. The recognition may be no more than this vague and indefinite feeling, a consciousness of "at homeness" and of "ease" and "acceptedness." From this it may reach any degree of definition until the object is located accurately in time and place. A melody comes drifting into consciousness in sensory or in imaginal form. It is familiar, it is accepted as a bit of revived past experience, but it cannot at first be definitely located. Little by little, however, if it is dwelt upon and attended to, related images and sensations are aroused in consciousness until perhaps suddenly and with great satisfaction the melody is recognized as one heard at the last opera. So complete may the recognition be that every little detail of the original setting may appear. Experiment, however, has proved that recognition need not involve images. Tones, colors, objects of any sort, may be recognized as having been experienced before, and yet the observer may be unable to detect any trace of imagery accompanying the experience. Although recognition is the best subjective guarantee of the accuracy of memory, yet it often fails, and we recognize as

old many objects that are new; however, once the object is accompanied by the characteristic of familiarity, then consciousness can produce no better evidence of its memory character.

Experimental Studies of Recognition.—In the experiments whose problems and general results are now to be indicated the typical method of procedure is as follows: (1) Colors, grays, odors, tones, pictures, advertisements, nonsense syllables,[1] whatever it be, the material for study is selected. (2) This selected material is now presented to the subject either serially or in pairs. (3) It may be presented from time to time until the subject has mastered it. And (4) at the end of any trial the material may be presented to the subject in the same arrangement in which it was given originally or in a different one, in either case mixed in with new material. The subject is now instructed to state which material and arrangement are familiar and which novel. He may also be requested to describe frequently and in great detail what is in his consciousness when he experiences "familiarity." This is an illustration of the introspective analysis by which the structure of consciousness is laid bare.

Experimental studies of recognition have concerned themselves chiefly with the following important problems: (1) The analysis and description of the recognition consciousness. We have pointed out certain of the conclusions reached in our preceding section. (2) The relative accuracy of recognition and recall. The general result here has been to demonstrate that such material whose retention is so slight that recall is impossible may still be recognized when presented to the observer. Thus I may be unable to repeat a given stanza of poetry and

[1] Nonsense syllables were first invented by Ebbinghaus (1885), the pioneer student of memory, whose contribution we shall study under retention. They are constructed of two consonants with a vowel between. The syllable so constructed must not be a word with meaning and it must suggest an actual word as little as possible. Examples are: rik, rih, lan, sul, ruc, bez.

yet be able to pick out with a high degree of accuracy the proper stanza from other slightly varied versions. Recognition is thus possible with a less degree of retention than is recall. (3) The dependence of the accuracy of recognition upon the significance of the material. It has been shown that recognition is more accurate where the material used makes sense (advertisements, pictures, words) than where nonsense syllables are used. The difference undoubtedly lies in the relatively larger number of associations present in the more meaningful material. This increase in the number of associations makes possible readier arousal of the feeling of familiarity and accordingly facilitates recognition. (4) The relation of accuracy of recognition to lapse of time. The above principle accounts for the fact that the ability to recognize nonsense material decreases very rapidly at first and then more slowly, whereas the ability to recognize certain significant material undergoes hardly any loss with lapse of time. The ready reinstatement of the characteristic of familiarity under these last two conditions is further aided by the fact that meaningful material becomes closely associated with words, i.e., it becomes named. The name is long remembered and readily brings "familiarity" into consciousness.

The Problems of Retention.—Retention, as we have said, is a purely physiological affair, the study of which is fundamental for an understanding of memory. Since, unlike recognition, the study of retention is objective, behavioristic, we do not ask the subject for a description of his consciousness. Other methods of investigation must be used, the following ones being most important: (1) We record the number of trials and the time it takes the subject to master a given amount of material so that he can recite it or otherwise reproduce it without error. Later, after a certain lapse of time, we have him relearn the material. The difference between the amounts of time and the number of trials of the first learning and the second is a

measure of the amount retained. The greater the effort required in relearning the less the retention is. This is the *saving method* devised by Ebbinghaus. By varying the conditions under which the learning and the relearning are done, it is possible to study the effects of such conditions upon retention. (2) A second method is that of *recognition*, the details of which we pointed out in the last section. (3) *The method of paired associates*, devised by Calkins and perfected by Mueller and Pilzecker, is as follows: The material is presented to the subject in pairs (of words, nonsense syllables, etc.). It is read through a specified number of times, and then the first members of the pairs are shown the subject in a changed order. He is now requested to recall their associated second members. Retention is measured by the length of time that it takes him to recall the material and by the proportion of right to wrong answers. Thus the series *a–b*, *c–d*, *e–f*, *g–h*, is shown to the subject one pair at a time, each for one second. After the fifth reading, let us say, the subject is then shown *c*, *g*, *a*, and *e*, and requested to recall the syllables associated with each. Here again variations in the conditions under which the pairs are learned will result in changes in the scores, indicating the influence of the varied conditions on retention. A typical apparatus used for presenting the material in each of these cases is shown in Fig. 54.

Not only is the problem of retention essentially a behavioristic question, as we stated above, but it is essentially the problem of habit. Habit is an acquired co-ordination of reflexes just as instinct is an inherited one. More simply stated, habit is an acquired form of muscular or glandular response. Underlying it there must be an acquired connection of nervous elements. Ordinarily when we think of habits we tend to think of movements of the hands and feet as in writing and dancing, but speech is also a habit, and the same principles apply to both instances of habit-formation. To connect

one sound (cat) with another (dog) is as much a case of habit-formation as the connection of the different steps in a dance. Where two or more trials are necessary before the connection can be made, what is learned in the early trials must be retained in order that learning may be completed. Since retention, therefore, is as necessary to the parts of a habit as to the completed form of response, our study of it consequently covers the

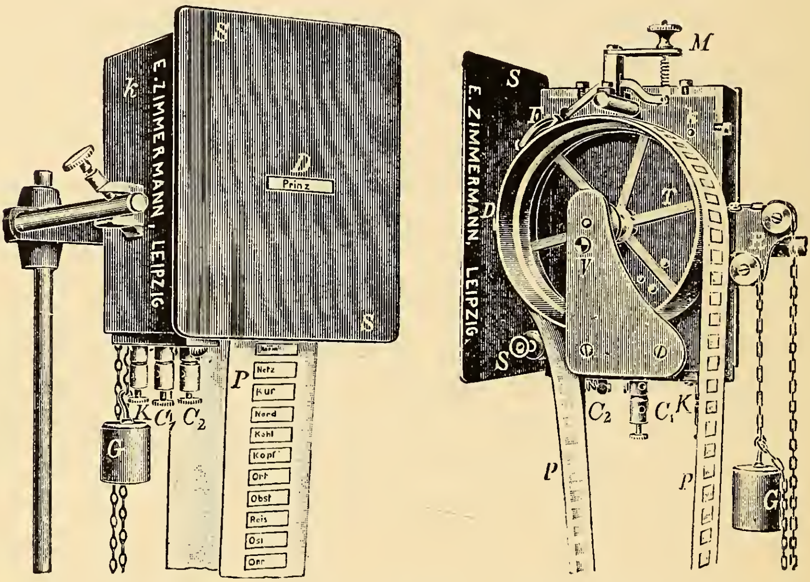

FIG. 54.—Wirth's memory apparatus. This apparatus makes possible the serial presentation of material to be learned. The exposure time can be accurately controlled.

learning process and the nature of forgetting. Most of the experimental work has been done upon language habits using two methods: studies of associating words together by employing poetry, nonsense syllables, and similar material; and studies involving words or gestures to indicate other sensory material employed (odors, tones, etc.). Some work has been done upon non-language habits. Here the work has concerned the question of the acquisition of skill in typewriting, telegraphy,

shooting, running the maze (rats), etc. Both classes of problems are true habits. Both are in an equal degree acquisitions of skill.

Conditions Favorable to Learning.—Experiment has shown that the following factors hasten learning: absence of fatigue, concentrated attention, pleasure, rhythmical material, an optimum rate at which the material to be worked up into a habit is presented, presence of significant meaning in the material, practice, distributed effort, the use of the whole as opposed to the part method, intention to remember, and the absence of interfering habits or associations. Since it is inexpedient to present here the data that go to substantiate all of these statements, comment will be made only upon a few. In each case the student will do well, however, to plan out an experiment suited to the investigation of the influence of each factor upon habit-formation.

Learning Significant versus Nonsense Material.—Significant material, i.e., prose, poetry, pictures, etc., is more readily memorized than an equal amount of nonsense material, and, moreover, it is better retained. Thus Radossawljewitsch, working with the saving method above described, found the relative retention of poetry and nonsense material to be as follows:

Period since learning was completed	Per cent of nonsense material retained	Per cent of poetry retained
5 minutes	98	100
20 minutes	89	96
1 hour	71	78
8 hours	47	58
24 hours	68	79
2 days	61	67
6 days	49	42
14 days	41	30
30 days	20	24
120 days	3	..

Significant material owes its advantages to its large number of associations, its superior interest, and the groupings into phrases, clauses, sentences, and topics that it contains. Consequently its memorizing does not involve so much *de novo* learning as does nonsense material, for many of the desired associations are already set up before the learning begins. In order to utilize these preformed associations that underlie meaning, the subject must grasp the idea involved in the material presented, thereby accomplishing much of the learning. Sheer frequency of repetition, however, must complete the acquisition. Since the amount and complexity of meaning in significant material vary greatly, learning and retention, consequently, vary greatly. It was to control this factor and make the meanings of all material on a par that Ebbinghaus devised nonsense syllables.

Remote Associations.—We have seen that significant meaning is an aid to learning by virtue of its effect in grouping certain portions of the material into larger units than words. However, associations are formed not only between immediately succeeding parts of the material (language or non-language habits) but also between remote parts. The clearest cases in non-language habits are instances of the actual elimination of certain intermediate responses—usually referred to as the "elimination of random movements." Thus a rat in learning to run a maze (see Fig. 4, p. 23) (1) runs slowly along the true pathway, (2) turns into a cul-de-sac, (3) turns and runs out, and then (4) continues along the true pathway. In practically every case the animal finally learns to associate 1 and 4, eliminating 2 and 3. The omission of the cul-de-sac may first occur accidentally and then be repeated as a result of pleasurable results and recency, until frequency finally completes the learning. Another type of remote association may also be cited, food, e.g., secured at the *end* of the maze soon furnishes the animal a motive for vigorous and purposive efforts at the beginning of the maze where at first only curiosity and random wandering were manifested.

Experiments upon language habits using nonsense syllables have made possible a more detailed understanding of these remote associations. Ebbinghaus tested the matter in the following manner: He constructed six series of 16 nonsense syllables each, which the subject repeated until he could reproduce them without error. Twenty-four hours later the syllables composing each series were rearranged and then relearned, the rearrangements consisting in placing side by side syllables that had originally been separated by 1, 2, 3, or 7 intervening syllables, and also a series where the first and last syllables were retained in place and the others rearranged by chance (referred to in Table 2 as "permutation of syllables"). When these rearranged series were learned after the twenty-four-hour period, the amount of time saved in the relearning was an indication of the amount of association between the remote pairs. The following table taken from Ebbinghaus[1] indicates the results:

TABLE 2

(The numbers of the four middle columns denote seconds)

Number of the intermediate syllables skipped in the formation of the derived series	Time for learning the original series	Time for learning the derived series	Saving of work in learning the derived series	Probable error of saving of work	Saving of work in percentage of original learning time
0	(1,266)	(844)	(422)	....	(33.3)
1	1,275	1,138	137	±16	10.8
2	1,260	1,171	89	±18	7.0
3	1,260	1,186	73	±13	5.8
7	1,268	1,227	42	± 7	3.3
Permutation of syllables	1,261	1,255	6	±13	0.5

From this it is apparent that the strength of the association between remote pairs is dependent upon the extent of their remoteness. The far-reaching effects of association shown by

[1] H. Ebbinghaus. *Memory*, p. 106; trans. by Ruger and Bussenius. New York: 1913.

this test serve to hold conscious states and muscular responses together in a thoroughgoing unity. In the following sections on "Habit-Interference" and "Transfer of Training" we shall see in detail other ways in which experiences interact.

Habit-Interference.—It is a matter of common knowledge that many habits interfere with the formation of new ones. If I have a habit of securing a book from a certain shelf, it is difficult to shift and begin taking it from another. Habits of all kinds are hard to change, for they represent firmly intrenched pathways in the nervous system over which nerve impulses flow most readily. Early in the experimental study of memory it was shown that if a series of nonsense syllables, *A*, was associated with another series, *B*, the association of *A* with a new series, *C*, was impeded or interfered with. This agrees with the familiar observation that if two names are equally employed, one is often unable to recall either when occasion arises.

There is an additional type of interference in language habits that is worthy of notice, the phenomenon of *retroactive inhibition.* Associations in the nervous system require a certain interval of time in which to "set," and if this interval is not forthcoming because of the too early onset of new associations, the first ones are retroactively inhibited. Students taking lectures meet this phenomenon constantly. The professor makes a point, but before the point can be assimilated another is brought forward and insistently emphasized, with the result that the former is forgotten.

In the field of habits other than those of language, interference is equally prominent. With animals below man, Hunter and Yarbrough have shown and Pearce has confirmed the fact that interference is strikingly present in the learning of rats. If rats are trained to run to the right through a box when a certain noise or light is given and to the left for silence or darkness, it is extremely difficult to reverse the behavior for slightly different noises or lights. The former writers have

shown also that two habits in response to very similar stimuli, although at first interfering, can soon be so thoroughly mastered that either may occur without any interference whatsoever. This confirms similar data secured in man by Münsterberg and Bair.

Transfer of Training.—Interference is the negative side of habit interactions, while transfer is the positive side. Does training upon one topic aid in the mastery of others? Is there, for example, any reason to believe that the acquisition of habits in mathematics will aid in the acquisition of habits in psychology? To what extent can one have a formal discipline that is valuable irrespective of the content of the habits to be acquired? *Transfer does occur on a large scale.* Habits that have been acquired do aid in the acquisition of new ones—in fact that is the only manner in which new habits can be built up. The aid is not, however, the training of some mental faculty or capacity. One habit aids another to the extent that the two involve common elements. These common elements may be an inclusion of part of one habit in the next: e.g., the same nonsense syllables may occur in two series, or mathematical formulas may be present in psychology as well as in mathematics. Experiments that rule out such an overlapping and that still show positive evidences of transfer are to be explained on the basis of common elements of the following type: more efficient attention, improved methods of study, increased resourcefulness, and application of economical methods of learning.

Effects of Practice and Intention.—These two important conditions affecting the degree of retention are grouped together solely for the convenience of brief discussion. Individuals who practice the acquisition of any type of task improve their retentive capacity markedly. This improvement which may occur in memorizing nonsense syllables, poetry, scientific formulas, or other material is to be explained as a particular

instance of transfer where improved methods of learning are utilized. As a striking instance of practice effect we may give the case of Dr. Rueckle, a mathematical prodigy tested by G. E. Mueller (1913). After six years' practice on the stage he could memorize 204 digits in less than 9 minutes. Prior to this time it had required 18 minutes. His ability to memorize colors, syllables, etc., however, had decreased, a condition that was undoubtedly due to the interference with his new habit of learning.

Experiment has shown that retention is better when the *intention to remember* is present at the original moment of impression. This factor makes a large part of the difference between incidental and purposeful remembering, for one constantly sees and hears things that are not remembered, or that are recalled inaccurately. What type of figures are on the watch you carry? What is printed on the two-cent postage stamp? To retain well it is important to intend to retain. Not only is this necessary, but it is also important at the time of impression to know how retention is to be tested. If the method of paired associates is to be used, the subject concentrates upon the connections by pairs. His attitude is different, on the other hand, if he is to be tested by the saving method. Students experience this difficulty when they attempt to master certain material without knowing the exact method by which they are to be examined. Furthermore, material learned by "cramming" for examination is usually forgotten early, for although the intention is for retention, still it is for temporary and not for permanent retention. The ability to acquire a large amount of information for a temporary use is of great value to lawyers, teachers, and individuals in many professions who meet situations of this type constantly. It is wise after all that most of the detail we learn should be soon forgotten!

In experimental procedures the subject is ordinarily instructed not to recall the material between repetitions. In

practical life, however, repetitions are constantly made from memory. This habit has both its advantages and disadvantages. Errors are prone to creep into these repetitions and so are sure to be fixed and retained as well as the correct material. Aside from this, however, Witasek has shown that the active recall required in these repetitions from memory is far more advantageous for retention than the more passive repetitions of the continued reading of the passage to be learned.

The Whole versus the Part Method.—In our discussion of repetition the question at once arises concerning the method to be used in any problem of memorizing. When the average person attempts to learn a given amount of material he divides it into small units of material, and masters the task one unit at a time. He learns section by section in a psychology text or one stanza of a poem after another. It was shown by Lottie Steffens (1900), however, that memorizing by *parts* is less efficient than memorizing the material as a whole, i.e., reading over the entire task each time. This rule is even more applicable to significant material than to nonsense material. The gain comes, according to Meumann, largely in the fewer number of repetitions required and in the better retention. The whole method owes its advantages to the following facts: (1) it aids a uniformly distributed effort and a sustained attention; (2) in meaningful material the total significance is best grasped by reading through the entire task; (3) part learning not only requires that each part (stanza, for example) be learned, but in addition special learning must be used to join the parts together; and (4) part learning produces many faulty associations. If we use stanzas of poetry as the illustration, part learning associates the end of each stanza with the beginning of the same stanza and not with the beginning of the following one. The whole method is disadvantageous, however, when the material is so long that the effort involved is fatiguing and when the progress of learning is so slow as to be discouraging.

Furthermore, when the material is of very uneven difficulty, the method is bad to the extent that it requires as many repetitions of the easy as of the difficult sections. In such cases it is best to underscore or otherwise mark the difficult passages so that extra effort may be concentrated upon them while the part already mastered may be skimmed easily and rapidly. As yet insufficient experimentation has been done to warrant an extension of the law to other than language habits, although work by Pechstein on rats and humans in the maze indicates its presence there.

Distribution of Effort.—What variation is secured in the learning process by giving the trials far apart as opposed to close together? What effect does it have upon the economy of learning to distribute one's effort through a long period of time? The more the effort is distributed in time the less the number of trials required for mastery, and, vice versa, the more the effort is confined to a short period of time the greater the number of trials necessary for mastery. If fifty lines of poetry, for example, are read over once a day, or once every other day, fewer repetitions will be required to learn them than if they were read over two, three, or more times daily. It must be noticed, however, that distributed learning extends over a longer period of time than does concentrated learning. One method is economical in extent of time required, the other effects a saving in the number of trials. This is true not only for language habits as we have just outlined, but it is also true for other habits. Ulrich, as we saw on page 29, has demonstrated it for problem-box learning in the case of the white rat, and Lashley has shown it to hold for men in learning to shoot with the crossbow. The rule, it seems, however, is more applicable to large than to small masses of material.

The explanation of the efficiency of distributed effort lies partly in the fact stressed under retroactive association and partly in facts formulated as *Jost's law*. Under the former

we may recall that it takes a certain interval of time for an association to "set" after it has once been made. If a second association is begun too soon, it interferes with the retention of the first. Distribution of effort permits this setting of synapses to continue uninterruptedly. Jost (1897) performed a series of experiments which indicate clearly that an older association is retained better than a newer one. Additional repetitions, moreover, strengthen the older association more than they do the newer one, e.g., if one memorizes fifteen nonsense syllables today and fifteen tomorrow, the former group will be remembered the longer (if both begin at equal strength). Furthermore if I repeat each list once at the end of a week, the repetition will improve my memory for the older habit more than for the younger. Jost formulates his law as follows: "When two associations are of like strength, but of unlike age, repetition increases the strength of the older more than of the younger associations. When two associations are of equal strength, but unlike age, the younger fades more rapidly than does the older."

The Training and Economy of Memory.—The importance of a consideration of the foregoing principles of learning lies in the fact that a trained memory is an economical memory, or, to put the situation in more adequate terms, *a trained capacity for the acquisition of habits implies a training in economical acquisition.* Whether or not a given method of habit-formation is economical depends largely upon the purpose for which the habit is to be formed: if one does not wish to retain for a long time, the intention to remember will be in accordance with that purpose; and if one wishes to economize the *extent of time* devoted to a task, he will concentrate, not distribute, his efforts. It often happens that one does not desire the ability to repeat a given material from beginning to end, the important thing being, perhaps, the ability to reproduce isolated points (parts). In such instances the part method is undoubtedly

more economical than the whole method. Consequently one must vary his methods constantly to suit changes in the purpose to be attained. To conclude the matter, we may say that the chief secret of a highly trained capacity for habit-formation is the ability: first, to formulate clearly the end to be accomplished; second, to concentrate attention upon the successive trials (repetitions) with the intention of accomplishing the purpose; and third, to suit the method used to the purpose to be attained. The greater apparent economy of adult memory is due to the increased experience, i.e., it lies in the increased wealth of meanings that makes the utilization of these three points possible in a high degree.

Nature of Forgetting.—So far we have discussed retention from the positive side, that is, from the point of view of learning. When we have described the formation of various habits, we have spoken only of the individual associations or parts that have persisted from moment to moment and so *have entered into the constitution of the final perfected habit.* At each free repetition of the material that is to be worked up into a habit errors occur until the last stage of completed learning is attained. If the individual is learning nonsense syllables, he mispronounces and fails to recall properly, or he may even give syllables not on the list; that is, his vocal muscles make wrong movements. If he is learning to typewrite or to run a maze, he is continually making wrong movements with his hands or feet. When, however, learning is completed, these erroneous responses have been eliminated, i.e., they are forgotten so far as that particular habit is concerned. This fact that all nervous processes which are not at the moment included in the present and ongoing habit are "forgotten," temporarily eliminated, is the fundamental nature of all forgetting. Accordingly, as I write these lines, habits of eating and talking are eliminated, though later they may be reinstated or recalled. Since states of consciousness—sensations, images, emotions, etc.—accompany and are

dependent upon certain neural processes, *if the neural processes are not included in the present ongoing habits and instinctive adjustments the conscious states in question are eliminated, forgotten.*

In a coming section on "The Fixation of Arcs in Habit" we shall inquire into the detailed causes for the elimination of the erroneous responses during habit-formation. Our last few sentences, however, pointed out another and secondary form of forgetting. I am not now at the present moment in any real process of habit-formation. I am actually engaged in a habitual response, writing, i.e., I am now *recalling* this retained possibility into action. But there are very many other retained traces in my nervous system conditioning other possible habitual responses in which I might now be engaged. Why are not these habitual responses now reinstated, or, to put the matter the other way around, why are they eliminated at the present moment and forgotten? To state the case from the standpoint of consciousness, why am I here and now conscious of what I happen to be aware of and not of some other thing that is excluded, eliminated from consciousness? Why are certain nervous processes and not others active at this moment? The question of forgetting or eliminating consequently presents itself in two forms: (1) At the time neural associations (habits and instincts) are formed, why are certain neural associations excluded? This is the primary and fundamental question. (2) Why at any one moment are many neural associations passed by and not recalled into activity? Why are they eliminated from the activity of the present moment?

We shall discuss the former of these questions under the heading of "The Fixation of Arcs in Habit." Our comment on the latter question is as follows: A given state of consciousness or form of behavior is absent (forgotten) at the present moment, either: because of the absence of proper stimulus; because of the interference of other habits or neural processes; because of

the active repression of the forgotten item; or by virtue of disuse which has rendered re-excitation difficult. This last factor we must now discuss at greater length.

Rate of Forgetting.—In what way, may we say, does forgetting proceed under the influence of disuse? Does one gradually retain less and less as time goes on? Experiments began with Ebbinghaus, and they have shown that the loss in retention is greatest at first and then grows less and less until there is practically no further decrease. Ebbinghaus' tests have been repeated, notably by Radossawljewitsch, and have been confirmed except that the later students have found less rapid initial loss of retention. The following account summarizes the results of the two studies mentioned above upon nonsense syllables: According to Ebbinghaus, 55.8 per cent is forgotten at the end of an hour and practically 75 per cent after 6 days. According to the more reliable data of Radossawljewitsch 50 per cent is not lost until 8 hours have passed, but most of this is recovered on the following day, so that a permanent decrease of 50 per cent is not found for 6 days. Popularly one regards the rapid learner as the quick forgetter. Much evidence has been secured, however, indicating that the contrary is the case and that the one who learns quickest also retains best.

"The Fixation of Arcs in Habit."—We return now to the question of primary importance in our discussion of elimination. At the time neural associations are formed why are certain ones excluded? In this connection Watson has made use of the phrase "the fixation of arcs in habit" in referring to the essential factors that determine the fixing of acquired associations between reflex arcs. For convenience we shall phrase our statements positively and speak of factors making for fixation and retention, though we are at the same time pointing out the factors that make for elimination and forgetting. If, for example, the more recent response tends to be repeated, we are also saying that the less recent tends to be overridden by the

more recent. Before enumerating and evaluating these different factors, let us formulate the steps in habit-formation in such a way that they will be as applicable to the formation of a typewriting habit as to the habit of repeating "My Country, 'Tis of Thee."

Angell enumerates the following stages: (1) appearance of the stimulus, (2) random movements, (3) accidental success, and (4) elimination of all or of most of the random movements. I see the typewriter before me. My hands make clumsy, awkward, slow movements. My body as a whole is strained and perhaps contorted. From time to time I make proper movements and succeed in my writing. Gradually my awkwardness vanishes, and I write accurately, at great speed, and with a minimum of effort. Let us take a language habit in order to illustrate the stages still further. (1) I see a list of French words and their English equivalents before me. (2) I repeat the list over and over with much bodily tension and with many random movements (mistakes) of the vocal organs. (3) From time to time I succeed in repeating portions of the list. (4) Errors are finally eliminated and the habit is complete. Many habits, however, as contrasted with these, are formed unconsciously, such as mannerisms of walking, talking, and dressing, which we suddenly notice are here, though of their coming we knew naught. It is important to note in our own present discussion that, with those habits whose formation is accompanied by consciousness, as the habit becomes more and more perfected, more and more automatic, consciousness disappears and ceases to accompany it. Finally I typewrite or repeat the French-English vocabulary list with practically no consciousness of what I am doing.

Our fundamental question here is with reference to the *elimination of random or unsuccessful movements.* Three prominent psychologists have recently presented views that require comment: Thorndike (1911), Carr (1914), and Watson (1914).

The factors making for the fixation of associations according to Thorndike are frequency (the law of exercise) and pleasure (the law of effect). According to Carr, they are frequency, recency, and intensity, and according to Watson frequency and recency only. In our own mind there is every reason to believe that frequency, recency, and the *neural processes underlying pleasure* are the important factors. Upon frequency all are agreed: a succession (contiguity) that is frequently repeated is thereby fixed. The neural connection underlying a movement recently made retains a low resistance and so tends to be retraversed immediately. The genuine dispute comes over the effect of pleasure. A child is given disagreeable medicine and thereafter refuses it. I make a mistake in my English-French vocabulary. Since it is unpleasant I do not make it again, thereby eliminating that random movement; and if the elimination is thoroughgoing I do not even have an image of the mistake made. But how can pleasantness and unpleasantness, which are conscious processes, influence chemical or electrical processes in the synapses? This has been the universal objection to rating affection as a causal factor, an objection which is well founded. There can, however, be little doubt that something connected with these conscious states affects learning, that in some way the neural processes underlying pleasure facilitate those other neural processes contiguous to them. We would therefore agree with Thorndike, but speak more objectively, and not refer to consciousness affecting the body. On the other hand, we would explicitly recognize the effect of pleasure's neural basis rather than, with Watson and Carr,[1] deny any effect.

Curves of Learning.—So far in our account no comments have been made upon the progress of learning in the case of the formation of a specific habit. How does the elimination of

[1] I believe, however, that Carr tends to include with intensity the bodily disturbances underlying pleasantness and unpleasantness.

random movements proceed? Is it a gradual process or is it one of relatively sudden changes? Most experimental studies of learning have contributed data upon this point, although much still remains to be done in the way of analysis of the factors determining the form of the learning curve as opposed to its length (the problem essentially of economical methods of learning). Curves presenting typical results were given in the

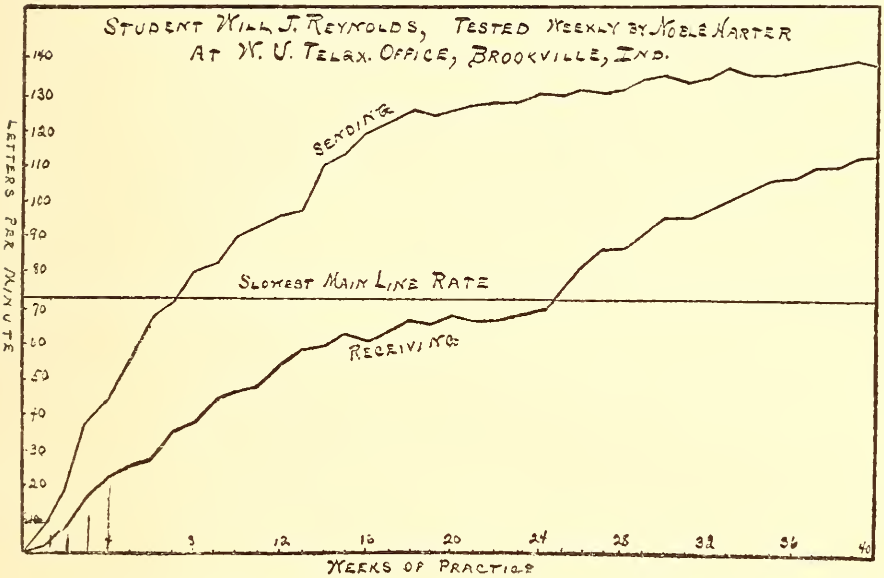

FIG. 55.—Learning curves for telegraphy secured by Bryan and Harter.

chapter on "Animal Psychology" (p. 24) and in the chapter on "Instinct" (p. 167). The accompanying figure (Fig. 55) shows results secured in a classical experiment upon telegraphy by Bryan and Harter. The data upon which these curves are based were partly secured by questioning telegraphers and partly by experiment upon several individuals who were learning the trade. The latter subjects were tested at stated intervals during their learning period in regard to their ability to send and receive letters that did not make words, words that did

not make parts of sentences, and meaningful groups of words. The curves show the progress through weeks of practice in terms of the number of letters that could be sent or received per minute. Attention should be drawn to the following characteristics: (1) There is rapid progress in the first part of the curve indicating a relatively easy and consistent improvement. (2) The receiving curve remains below the sending curve for the greater portion of the learning. (3) The receiving curve shows a period of little progress, or a *plateau.* (4) Each curve tends finally to reach a level of little progress—the level of final ability. In explanation of the second characteristic Bryan and Harter present many factors that we cannot list, but all of which indicate the greater difficulty of receiving.

The characteristic of chief interest is that of the *plateau,* which results from a slowing up in the relative rate of progress. This feature is found in innumerable cases of learning. One begins to play tennis, for example, and advances splendidly for a time. Then try as one will, his serving remains inaccurate, or he will return the ball out of bounds. If effort continues, however, this plateau will be passed perhaps in a sudden burst of ability that carries one to a much higher level. The same is true in chess, in golf, in typewriting, and in other habits. Some curves do not show plateaus, such as the sending curve given on page 315 and the maze curve on page 24. Plateaus may be due to any one of many factors of the following type: discouragement, poor physical condition, lack of effort, use of inappropriate responses, and the formation of subsidiary habits. The last point is the one stressed by Bryan and Harter, receiving being a complex or hierarchy of habits in which progress depends upon the mastery of the responses of least complexity. Habits must be built up for letters, words, and word-combinations. The first two are acquired easily but the higher language habits come more slowly. "A plateau in the curve means that the lower-order habits are approaching their maximum develop-

ment, but are not yet sufficiently automatic to leave the attention free to attack the higher-order habits. The length of the plateau is a measure of the difficulty of making the lower-order habits sufficiently automatic."[1]

We have emphasized but one characteristic of learning curves, and we have presented only one experimental study out of many dealing with it. Mention might be made of the fact that peculiarities in the rises and falls of curves have been used to differentiate rational learning from that of a haphazard trial and error type, but our knowledge is as yet too inexact to warrant more extended comments here. Enough has been said, however, to indicate the type of problem that arises in the study of the progress of habit-formation or, negatively stated, in the progress of elimination of random movements. We must now turn to the question of the function of habits after they are formed.

The Function of Acquired Modifications of Behavior.— Acquired modifications of behavior, habits, are automatic responses that are called forth by the presence of any of a certain class of stimuli. There are stimuli for writing, for reading, for talking, etc., each class calling forth its appropriate response which has been built up on the basis of plasticity and retention, as we have described. What functions do these acquired associations perform? In answering this question we may well call to mind the answer to a similar one raised in the chapter on "Instinct," page 175, where we had to deal with inherited modifications of behavior. Instincts serve to adjust the organism to its environment in ways that have proved not too disadvantageous in the past history of the species. Likewise habits serve to adjust one to his environment in ways that have proved not too disadvantageous in his own lifetime. Each automatism, whether an instinct and inherited or a sequence of vocal

[1] W. L. Bryan and N. Harter, "Studies on the Telegraphic Language. The Acquisition of a Hierarchy of Habits," *Psych. Rev.*, VI (1899), 357.

contractions giving rise to the sounds of nonsense syllables and so acquired, *enables the individual to bring past experience to bear upon the present problems.* Solutions that have once been worked out may now be applied without repeating the process of learning. Speech is a solution of the problem of intercommunication; running is the rat's solution of the food-getting problem; and the automatic association of cortical nervous processes that gives rise to the sequence of images "Battle of Arras, 1917" is my solution of the problem "What is a recent decisive battle of the world-war?" In either of these cases the association has been set up by having the essential parts retained and the erroneous, random parts eliminated. These habitual responses are "set off" by the appearance of their stimuli (problems) without relearning. *They thus conserve energy and increase the efficiency of response.* This function of acquired forms of response has its fullest development in that highest type of human behavior, termed thinking, to a study of which we now turn.

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CHAPTER X

THINKING

Introduction.—Our study of thinking involves an analysis that can only be slightly behavioristic, or objective. It is largely an introspective field where at the best one can only insist—and it is important to do so—upon analogous phenomena in the field of habit-formation and association. The problem is essentially, *What* is in consciousness when "thinking" takes place, and how does this content change from moment to moment? Although philosophy and psychology come most closely together in their account of this topic, we shall encounter from time to time certain fundamental differences between the psychological account and the traditional logical account. As we proceed, it will be well to keep in mind a definition of thinking as *a purposive sequence of states of consciousness* (Watt, 1905, and Ach, 1905).

The Nature of the Concept.—We have already become familiar with moments of consciousness termed sensations, images, and emotions, and we have seen that each possesses meaning. This meaning is the significance of the experience, that for which the moment of consciousness stands. If we speak from the point of view of the nervous system, meaning refers to those neural conditions that determine the nature of the organism's response. So far in our statements concerning meaning we have taken account only of those cases where the significance of a conscious moment is its reference to an individual object. It has been pointed out that a sensation of red may mean any one of a number of specific things—apples, or barn, or sunset. In a similar manner I may have a centrally aroused consciousness of red—an image of red—and it may mean (refer to,

stand for) the same objects. An emotion of fear or anger may also mean any one of many specific things; for example, it may signify "need for immediate flight" or "the presence of the enemy" or "a case requiring moral combat." As opposed to these instances where the state of consciousness refers to an individual object, we must now recognize cases where the reference is to a class of objects. Here one finds general and not specific meaning. *Any state of consciousness plus a general meaning is a concept.* I may have a sensation of red plus the meaning "red is a warm color." The reference is not only to this sensation but to any red sensation, and it is therefore general. I may experience the emotion of fear plus the general meaning "fear is an unpleasant emotion," or there may be the vocal-motor sensation or image of the word fear plus the meaning "unpleasant emotion." In each case the total experience is a concept, and the state of consciousness to which the meaning attaches is said to carry the meaning. Any state of consciousness can be a carrier of a *general* meaning just as all states of consciousness are carriers of individual meanings.

What can observation detect in my consciousness when I experience the concept "table"? I may be aware of the table which is actually before me stimulating my senses. The qualitative content may therefore be either visual, tactual, kinaesthetic, auditory, or any combination of these sensations. I need see or touch but a fragmentary portion of the table—a leg, a drawer, the top—any stimulation being sufficient to hold the meaning. The sensory material, however, which serves as a carrier of meaning need not be so concrete as in this case. It may be verbal, that is, I may have the kinaesthetic or the auditory vocal-motor sensation of the word table, or I may see the word. Furthermore, the quality may not be in sensory but in imaginal terms, such as an image of a part of the table, of its color, of its name. This image may be visual, auditory, or of any other type, depending upon the previous

sensory experiences of the individual. The nature of the qualitative content, therefore, is entirely irrelevant, for the general notion "table" may be in any terms that are associated with the general meaning.

What then am I aware of when I realize that whatever sensory or imaginal experience may be present stands for tables in general? This is a most difficult question to answer. I find that if attention dwells on the term, case after case of individual tables appears in the focus of consciousness as a result of association. This condition will, if I doubt, convince me that the term is a general one. Only in cases where doubt arises, however, do these associated examples appear, for ordinarily in thinking concept follows concept. The awareness of their general meanings is there; and yet no illustrative instances are aroused. Here the general meaning is represented in consciousness in the terms of kinaesthetic sensations arising from motor attitudes, which one can often describe, for example, as incipient gestures of assent or acceptance. We shall have a further word to add concerning this subject in the section on "Conscious Attitudes."

The Formation of Concepts.—In tracing the formation of a concept one is concerned with the origin and growth of the general meaning. Our understanding of this will be aided by calling attention to analogous phenomena in the field of behavior. Instincts and habits are generalized forms of response applicable to (or aroused by) any one of a given class of stimuli: eating is aroused by any object of food; the habit of typewriting applies to any given machine; fear and joy are aroused by any one of certain classes of objects. One may pursue the analogy as far in the animal scale as the amoeba. A negative tropism is a generalized form of response applicable to any one of a large number of stimuli. In a previous chapter we saw the impossibility of indicating the exact way in which instincts originated, but a fairly complete sketch was made of the process

of habit-formation. The development of a general meaning is essentially the growth of a habit, each constituting a case of learning. Most concepts are formed gradually, unconsciously, by the method of trial and error. We may suddenly realize that we have quite definite ideas (concepts) of right and wrong, of tables and chairs, and yet be quite unable to describe the process of their development. The factors at work are the same that we found in all cases of learning—frequency, recency, vividness, pleasantness, and unpleasantness. In concept-formation, as is the case with other habits, perfection is seldom attained. A rat learning to run a maze, or a child learning to write, may make the same useless, random movement so often that it becomes fixed and included within the completed habit. Likewise in the formation of the concept one may meet a certain situation so often that it is included within the concept by virtue of sheer frequency. Suppose that we are dealing with the concept picture. It may quite well be that all the pictures that I have seen are on paper. The meaning paper may therefore become included within the general meaning picture, although it is an irrelevant detail attached to the concept picture on the basis of frequency—a situation which is on a par with random movements in motor habits. Furthermore the concept of picture, that is, one's definition of a picture, may fail to include certain essential facts (associated meanings) because no necessity for their inclusion has ever arisen. Such a concept, or general meaning, is not so much wrong as it is inadequate. The same statements hold for habits in general. For example, my typewriting habit (series of associated motor responses) may be applicable only to a certain class of machines, because it is only this class that has entered my experience.

A brief sketch of the growth of a concept may make the situation more concrete. An individual is shown an object and the word ball is spoken to him. With a certain number of repetitions this association becomes fixed and the object

"means" ball. An apple may soon be encountered and because of its form may also mean ball. This is an error, a random movement, and is eliminated either as a result of parental instruction or on the basis of further experience which indicates that the apple means food whereas balls do not mean it. Various kinds of balls are met—large, small, soft, hard, and varicolored. Each calls forth the meaning ball, and frequency fixes the association in the absence of any factor tending to break up or discourage the association. At no stage does the child reason about the matter. At no time does he say, so to speak, "This new object must be a ball for it has the characteristics common to all the balls I know. It is round, can be thrown, etc." The formation and the elimination of associations between objects and meanings go on unconsciously in the vast majority of cases even with adults. Only occasionally does one set out explicitly to construct a definition, or concept, of a given class of objects. Thus a biologist may seek a correct conception of the species *amphibia*. Here he will assemble at one time all of the known data bearing upon amphibia-like animals. From the data the common characteristics will be abstracted and serve as a general meaning when associated with the name of the class. Although this process of concept formation may be vividly conscious, it remains, however, subject to the factors conditioning all learning. The question now arises concerning the value of these concepts whose formation we have studied.

Values and Limitations of Concepts.—The chief value of concepts lies in the increase in efficiency and economy of effort that they make possible. In order to make a statement concerning chairs, it is not necessary to re-see all chairs or even to call them up in imaginal terms. All that is necessary is the ability to reinstate in consciousness the concept chair which the experience of the individual has evolved as the adequate substitute for the individual awarenesses of chairs. Included

in the general meaning of this concept are all of those characteristics common to chairs which have been found essential to any thought concerning that entire class of objects. The concept thus represents a short cut in mental and neural processes. This statement becomes clearer by contrast with a description of the concept given by the great English psychologist, James Mill (1829):

The word, man, we shall say, is first applied to an individual; it is first associated with the idea of that individual, and acquires the power of calling up the idea of him; it is next applied to another individual, and acquires the power of calling up the idea of him; so of another, and another, till it has become associated with an indefinite number, and has acquired the power of calling up an indefinite number of those ideas indifferently. What happens? It does call up an indefinite number of ideas of individuals, as often as it occurs; and calling them up in close connexion, it forms them into a species of complex idea. . . . .

Have we not the idea of an army? And is not that precisely the ideas of an indefinite number of men formed into one idea? Have we not the idea of a wood, or a forest; and is not that the idea of an indefinite number of trees formed into one idea? . . . .

The following is, then, a very natural train:—1, The name occurs; 2, the name suggests the idea of one of the individuals; 3, that idea suggests the name back again; 4, the name suggests the idea of the second individual. All this may pass, and, after sufficient repetition, does pass, with the rapidity of lightning . . . . all in that small portion of time of which the mind takes no account.[1]

Careful observation of the nature of the concept, however, fails to verify Mill's logical analysis of what the concept ought to be. It is a much more unitary experience than Mill credits it with being. The many detailed mental processes which he mentions are eliminated during the process of concept formation. The very fact that all of these minutiae of past experience can

[1] James Mill. *Analysis of the Phenomena of the Human Mind,* Vol. I, chap. viii, pp. 204, 205, 209. London: 1829.

be replaced by one state of consciousness plus a general meaning, as we have indicated, constitutes the peculiar value of a concept and of conceptual thinking.

The limitations and dangers in the use of concepts grow out of the very characteristics that are their chief advantage. To stand for a class of individual objects, to include all of their essential characteristics, is to ignore the attributes peculiar to the specific object. Thinking, which largely goes on in terms of concepts, is therefore prone to overlook exceptions and to regard concepts as the "real" objects. Laws, customs, and tradition, as we outlined in our chapter on "Social Psychology," are conceptual systems, general formulas, which are applied to individual cases of behavior. It is a familiar fact in social life how conservative and slow to change custom is. The same condition holds in the intellectual life of the individual. Concepts represent fixed associations or habits that have proved more or less practical in the person's experience. They therefore resist change and hence may lead to serious maladjustment. The capacity to review the accumulated institutions and facts of civilized man and then to form new and serviceable concepts is rare and is the property of genius. The other defect of primary importance is exemplified in the history of philosophy. Philosophers have carried on great controversies over the probable realness or unrealness of concepts. Is there such an existence as chair or table in general, or are these merely names? It is aside from our domain to discuss the question, but it serves to redirect our attention to the importance in practical experience of the standardized meaning. Earlier (p. 221) we pointed out in the case of our perception of a rectangular table that the configuration of the sensory qualities was not rectangular but oblique, and that the perception was a pronounced instance of the supplementation of sensory qualities by centrally conditioned standard meanings in the light of which the table was viewed. These meanings conditioned the content of conscious-

ness by actually excluding the awareness of the obliqueness of the table. Likewise there are standardized general meanings or concepts which greatly influence our thought and manner of looking at things. The conventional definitions of men, chairs, and books, for example, which we apply to individual perceptions or images as they enter consciousness, prevent us from attending to the exact nature of our experiences as they present themselves. We thus see those things that are expected. The concept "soldier" applied to a man, for example, classifies him in a certain definite way and leads one to ignore the individual's other possibilities. Or, again, one customarily regards a book as an object to be read and so does not see that it is just as truly a small quantity of matter whirling annually about the sun. It is in this manner that customary concepts determine the nature of our experiences.

All that has just been said concerning concepts is equally applicable to habits of all sorts, because concepts are but the conscious side of certain neural associations. Habits—typewriting, playing the piano, drinking, etc.—are fixed and difficult to break. They are modes of response called forth by various situations—often wrongly called forth. For example, one plays the piano when the response to the situation might better be an activity of the language habit. From the conscious side his error is one of judgment, i.e., he has classified the situation under the wrong concept.

The Nature of Judgment.—With the topic of judgment we pass to the consideration of a more complex experience than we discussed in the previous section on concepts. Popularly, to judge is to pronounce upon some question, to settle issues or doubts. This judgment as formulated in language may be termed a proposition or statement. My eyes turn toward the desk and I say, "That is an inkwell," or, "The ink is black." These are completed and fully elaborated judgments in language form. I might have experienced the same thought, however,

without verbal accompaniment. In this case there would have been the visual perception of the combination of sensory qualities plus the meaning inkwell. In the second judgment above there are really two judgments, whether put in language form or not: "This is ink," and "It is black." *Judgment may therefore be defined as the assignment of meaning to the given qualities.* In the elementary form of judgments of identification it is impossible to distinguish between the conscious moment as sensation and as judgment. The same is true for emotions, affective processes, and other states of consciousness. In the non-verbal forms of judgment the demonstrative particles (this, that, there, here, etc.) are usually represented by cutaneous-kinaesthetic sensations or images involved in such activities as pointing, nodding, focusing and turning the eyes. So far as I recognize or identify the present complex of kinaesthetic and organic sensations as fear, so far do I assign meaning and therefore experience judgment.

Experimental Studies of Judgment.—Practically the only specific problem concerning the judgment that has been experimentally handled is that of its structural analysis. What can carefully controlled observation say of the content of consciousness during the moments when fully elaborated judgments occur? The general method is to present the observer with a problem for solution, a report of the experience being carefully given upon the completion of the task. Subsequent observations may be directed to special parts of the mental process involved, varying according to the interests of the experimenter. The problems used have been of two general types: (1) those requiring a discrimination and comparison of various sensory data, such as colors, tones, or weights (Schumann, 1898; Martin and Mueller, 1899; Whipple, 1901); and (2) those requiring the understanding and solution of certain "thought" material (Marbe, 1901; Binet, 1903; Watt and Ach, 1905; Buehler, 1907; and Woodworth, 1906–7). In the first method the

subject may be given a series of weights to lift in order to determine which is the heavier. Standard conditions are imposed to minimize the effect of extraneous factors such as suggestion, relative position of weights, etc. If the material used is sound, the observer may be given one tone of constant pitch to compare with the pitch of a variable one. The subject is instructed to observe and report upon the content of consciousness at the moment the judgment—"higher," "lower," or "equal"—is made. In the second method the subject is given a list of aphorisms and other sentences and is requested to read them understandingly and then to report upon the nature of the consciousness involved; or he is given a series of two relationships and requested to supply the third and then report (Woodworth). An example of this type of material is as follows:

Paris: France: : Athens: ———.

The experimenter constantly makes an effort to select material for observation that is thought-provoking.

These general methods, which we have outlined, are used in the experimental analysis of thought as well as in the study of judgment. The results secured by the investigations listed above lead us to consider the rôle played in these experiences by three factors: *the absolute impression, the image, and the conscious attitude* (*the awareness of the problem, or the Aufgabe*).

The Absolute Impression.—When we speak of an absolute impression we are drawing attention to the difference between the relative and the absolute. Without reflection, for example, we term various objects hot or cold. The inkstand in front of me I say unreflectively is heavy, whereas the one on another desk is light. Here are judgments involving comparative values, but close observation indicates that no conscious comparisons were indulged in. The inkstands give the impression immediately of being absolutely light or heavy, i.e., as belonging definitely on a certain side of the medium in a scale of

weight-intensities. In this manner we judge people to be large or small, lights to be bright or dim, tones to be high or low. "As lights go in my experience" or "as lights are usually found in laboratories," this one is dim. If I am questioned, associations may be aroused and conscious comparisons made; otherwise the stimuli give the "absolute impression" of the values assigned them. This impression is apparently made possible by the gradual and unconscious development of an association which stands for the typical or average experience to be expected. The type probably rarely enters consciousness but must be thought of as the neural counterpart of a possible conceptual experience. New awarenesses are unconsciously judged in terms of this standard or concept; and in so far as the process takes place automatically, the experience makes an absolute impression of heaviness. Martin and Mueller in their study of lifted weights —where a standard and a variable weight were tested and then compared as to heaviness—found a tendency to judge the variable as heavier, equal, or lighter *before* the standard weight was lifted. The fact is to be explained by the unconscious influence of the average-weight experience.

Whipple in his study of tones analyzes for us a case of absolute impression and indicates how certain motor attitudes carry the meaning of "higher" or "lower" in pitch. These motor attitudes are represented in consciousness in the form of kinaesthetic, cutaneous, and organic sensory complexes. Whipple says:

Judgments of "higher" and "lower," made without conscious reference to the image, are largely analyzable into complexes of strain sensations, with less prominent visual and organic elements, set free neurologically by the variable stimulus. The two chief factors, feelings of tightening and relaxation for "higher" and "lower" respectively, were reported throughout the tests with discrete tones, and were also well brought out with the wide differences used in the reaction method. We believe that these strains, which

are especially noticeable in the chest, throat, eyebrows, scalp, and about the ears, are explicable as symbols for "upness" and downness" in the tonal continuum, set up by every-day experience, especially in executing and listening to music.[1]

The Rôle of the Image in Judgment and Thinking.—The quotation just made from Whipple should remind us of the earlier discussion of recognition. Neither there nor here in our study of judgments was it found that images were necessary. In both cases it has been shown that, although present, the image may appear to play a negligible and irrelevant rôle. The addition of imagery to the content (sensation, image, emotion, etc.) that is recognized or that is judged is unnecessary, though in many individuals, perhaps, images may occasionally or even frequently be used in recognizing or in judging.

One may find various reasons for the assignment to images of a peculiar rôle in acts of thought. Chief of these is the momentum of historical usage. The philosopher-psychologist, upon whose shoulders until recently rested the burden of advancing the subject, placed an extraordinary overemphasis upon vision and visual images. The consequences we saw above in our account of association. Visual sensations cannot be produced and controlled by the organism. It is to be expected, therefore, that with vision occupying the center of psychological interest, thinking should have been regarded entirely as a matter of "ideas." These ideas were only images with the chief emphasis placed upon the attribute of meaning. The point was not yet reached where a structural analysis of the attributes of experience could be carried through. Qualities were therefore largely ignored and stress laid upon meanings; and these were assumed to attach in cases of thinking to images only. Our discussion of association places us in a position to view correctly

[1] G. M. Whipple. "An Analytic Study of the Memory Image and the Process of Judgment in the Discrimination of Clangs and Tones," *Amer. Jour. Psych.*, XIII (1902), 263–64.

the place of the image, and the results obtained from the experimental studies of judgment and thinking necessitate the following restatement of the rôle that it plays in our thought processes.

To think is to experience a purposeful sequence of conscious states as opposed to a non-purposeful or random sequence such as constitutes reverie. The only qualification necessary is that a greater or lesser portion of this sequence must be composed of states of consciousness which are under the organism's control and which, therefore, can be revived at will. A purposeful sequence composed entirely of images is an act of thought; but it is only one case and perhaps with most individuals it is very rarely experienced. The sequence may be of sensations, affections, or emotions. The practical, actual instances of thinking involve usually an almost inextricable intermingling of these, with images thrown in here and there. Many of the components of an act of thought need not be under the organism's control; i.e., visual sensations are often an integral part of the sequence, and we know that the organism's control over visual objects (and often of numerous others) lies essentially in its ability to place itself before them. On page 336 is outlined an instance of a train of thought where this is the case. However, connecting and binding this type of material together are processes whose stimuli can be directly controlled—kinaesthetic and auditory qualities.

The second primary reason for assigning images a peculiar rôle in trains of thought lies in the frequent profusion with which they appear when difficulties impede thinking. One may be proceeding fairly directly and easily toward the solution of a mathematical problem when suddenly a needed formula fails to arise in consciousness. Immediately a wealth of imagery may appear containing many possible suggestions—images of other formulas, and other problems, or imagery of the professor's face and manner, etc. Because of the prevailing interest in

ideas as described above, attention has usually passed over the fact that a wealth of sensory, emotional, and affective material is also called out in these moments when difficulties arise. The large array of conscious states and motor responses thus initiated owes its origin to the diffusion of nervous excitement through widely scattered portions of the nervous system. The explanatory principle so stated is similar to the law of *direct nervous action* used by Darwin to explain certain emotional expressions (see p. 190). Similar behavior occurs far down the animal scale. Whenever an organism is placed in a situation needing solution, first one and then another of its acquired and instinctive responses is called forth until the solution is reached or the animal is exhausted. The method is one of *trial and error.* Thus Thorndike found that a hungry cat placed in a box from which escape to food might be affected only by means of a latch would bite, scratch, and struggle until accidentally the solution was won. Such, furthermore, is the case with man. His actions may be controlled or spasmodic, but if they are consciously directed toward an end the awareness of them constitutes thinking. Out of the mass of organic responses and sensory, imaginal, emotional, and affective conscious material set free by the diffuse action of the nervous system, it is therefore impossible to select imagery as the peculiarly important solution material.

The Conscious Attitude.—The topic of conscious attitudes leads one at once into the heart of the problem known today as that of *imageless thought*, the experimental studies of which date from Karl Marbe's investigation of the judgment in 1901. The preceding discussion has indicated that in one sense imageless thought is an actuality, for thinking can proceed in terms of any conscious content. The so-called doctrine of *imageless thought*, however, postulates *pure thought*, *pure meanings unattached to any qualitative content.* It is said that after any given thought process has been analyzed into its component

sensory and imaginal elements, there still remains a phase termed variously the conscious attitude, a bare awareness, a naked elemental thought, an irreducible consciousness of relation. These processes are unanalyzable and cannot be described in terms of other conscious states. They must be experienced to be known. The subjects used in the experiments from Marbe to Buehler (1907) have reported this imageless thought in phrases as follows, the method used being described on page 330: "A conscious attitude appeared which signified to the observer, 'This is to be nonsense.'—'I was aware that this statement was false.' After the words of the spoken sentence died away, the thought appeared 'They are equal.'" I translate a typical observation from the experiments of Buehler in which the subject is instructed to answer when he understands, the time interval preceding the answer being measured and a description of the subject's experience being called for: "'If you would have the fruit from the tree, do not pluck the blossoms.'—Yes (7′5″).—The understanding appeared directly after the hearing. The ideas of fruit and blossoms were especially prominent. Thereupon the thought turned *to the causality which exists between them, to their temporal relation, and to the awareness that and how the point could be transferred to human relationships. No images were present.* Only the thought was present, that is, a beautiful picture (also without words)." Other observations of the same nature might be taken from Woodworth's studies of this topic.

The doctrine of *imageless thought* as here set forth does not seem tenable when viewed in the light of more recent critical and experimental evidence. In this country Titchener's laboratory in particular has performed similar tests in which the imageless thoughts have been shown to consist of sensory and imaginal components. From the theoretical point of view it has been urged (we think truly) that much of the experimentation which has yielded positive evidence has utilized problems

of such a nature that answers could be given automatically. Our previous discussions have shown the importance of this criticism by indicating that all forms of consciousness tend to disappear with the increasing automatization of a response.

The *Aufgabe*.—A genuine service has been performed by Watt in calling attention to the rôle in thought of the *Aufgabe*, or awareness of the problem. Watt's definition of judgment is similar to our own definition of thought: that is, a sequence of conscious states determined by the *Aufgabe*, or problem to be met. In many cases this *Aufgabe* has been in consciousness, and in many cases it still persists there during the process of judgment or thought. It is not merely, for example, the sequence of "cold," "water," and "shivering" which constitutes that sequence a judgment, but the train of conscious processes must be adapted to a purpose or end in view. Or, if we speak in terms of behavior, the sequence of responses must not be random, but must be co-ordinated for the attainment of an end (adjustment). "Cold," "water," "shivering," if they appear in consciousness as an answer to "the-result-of-stepping-off-the-bridge," constitute a judgment, or an act of thought. It will therefore be seen again that no sharp line of distinction can be drawn between what is and what is not judgment. All sequences, whether of consciousness or of behavior, are determined by certain factors; so the term judgment (or, with respect to behavior, such an odd term as "judgmental behavior") should be reserved for those cases where the determination or control of a sequence of conscious states is clearly adapted to a present problem. Accordingly spontaneous sequences, or free associations, are ruled out because, while they are determined by synaptic conditions, the determination is with reference to a situation dominant at an earlier date when the association was first fixed and not with reference to a present issue.

Analysis of a Concrete Act of Thought.—Our preceding descriptions of the content of thought and of the factors making

for a sequence of contents have furnished us the necessary background for an understanding of much that occurs in a concrete act of thought. In our present account we shall follow Dewey. Dewey recognizes five steps in each completed act of thought: (1) a problem or conflict, (2) the definition or interpretation of the problem, (3) suggested solutions, (4) the testing of the suggested material, and (5) the final acceptance or rejection of a given solution. The last act is both the logical and the temporal conclusion of the process. Let us consider the following illustrations: I am quietly reading in the evening. Suddenly the lights go out. Here is a problem. My habitual responses are interrupted, and in order to continue my adaptive behavior a solution must be found. My first interpretation of the problem is merely one of "sudden darkness." I continue from now on until the end to make more detailed and explicit the exact nature of this "sudden darkness," each suggested solution being an attempt at successful redefinition. Let us say that the first suggestion is that the wires in the lamp bulbs are burned out. This would define the situation as "sudden-darkness - due - to - burned - out - bulbs - remedy - insert - new - bulbs." The suggestion may come in sensory or in imaginal forms. I instantly test out the offered solution, either by further consideration (thought) or by actual inspection of the bulbs. In the first case associated processes related to the problem enter consciousness one after another. Earlier experiences are recalled in detail; but suddenly it is realized that all the bulbs are not likely to burn out at once, and I conclude temporarily that they have not done so. Actual examination reveals the fact that the bulbs are intact. It is now suggested that the generator at the power-plant has stopped, for in the city concerned there are past experiences that render this judgment probable. I am about to rest content with this solution of the difficulty, when suddenly I experience the thought, "But this does not enable me to continue

work." The insistency of the situation calls for further suggestions (random movements) until the possibility that the fuses are blown out appears in consciousness. No contradictory ideas intervene, and in a moment I am at the switchboard to verify the suggestion. The discovery that the fuses are really gone starts me on a search for others. When new ones are inserted the lights come on again. The actual appearance of the light is the final proof of the correctness or adaptive value of my judgment. In this manner one may describe any act of thought, the main steps of which are to be summarized as follows: first, a conflict or breakdown of responses due to a certain novel situation; second, the calling forth of all acquired and inherited responses of the organism until the problem is either solved or abandoned; and third, the acceptance of a given aroused response as the problem's solution on the basis of its ability to change the initial problem in the manner necessary to permit further adaptive behavior. In the illustration that we chose for analysis no striking instinctive behavior was involved. Let the organism, however, find itself in a difficulty involving food, self-preservation, or sex, and sooner or later the acquired associations will prove inadequate to adjust the individual so that, as a result, the instinctive responses need appear. These may or may not succeed. For example, a man caught in a fire may have suggested first one and then another mode of escape of which he had heard in times past. If these fail, he will undoubtedly be thrown into a panic of fear. His blind struggles now may accidentally free him of the problem; but if they do not there is no further recourse within the organism's control.

The foregoing analysis has said little concerning the content of consciousness. It is to be understood that sensations, images, emotions, concepts, conscious attitudes, and *Aufgaben* are all at work. The latter in particular function by limiting the associations which are aroused to those that bear directly upon the problem to be solved. As we said above, it is the

unifying effect of the *Aufgaben* which changes a mere sequence of experiences into an act of thought.

The Rôle of the Syllogism in Thought.—Logicians have placed much stress upon the syllogism as the typical formulation of an act of thought. The syllogism is composed of three judgments: the major premise, which states a general principle; the minor premise, where the particular object is referred to the general principle of the major premise; and the conclusion. There are many forms of syllogisms, but the following classical illustration may serve as typical of them all:

All men are mortal.
Socrates is a man.
∴ Socrates is mortal.

Any form of argument, any act of thought, can be cast into this form, so that the essential steps in the process are rendered distinct from each other and one is enabled to judge of the correctness of the conclusion. Logic has analyzed and classified the various types of errors under the heading of fallacies. These need not concern us here further than to point out that fallacious reasoning is non-adaptive behavior and as such is a genuine problem in the study of human nature. Not all purposeful sequences of conscious states will aid in the solution of the difficulty, or conflict, in which they arise. We may give two examples of fallacious thinking for the sake of further clarifying the matter, leaving the discovery of the error to the student:

1. What are feathers?
   Light comes from the sun.
   Feathers are light.
   ∴ Feathers come from the sun.

2. Why did the train stop?
   If the engineer sees a danger signal, he will stop the train.
   He stopped the train.
   ∴ He saw a danger signal.

Although any act of thought can be cast in the mold of a syllogism, it does not follow that thinking actually takes place in that manner. Psychology has been primarily interested in the actual processes that occur in thought, while logic has been largely interested in the analysis of completed acts of thought. Pragmatic, or instrumental, logic as championed by James and Dewey has fought this tendency and has made logic more psychological. Practically never do we use a developed syllogism in our thought unless doubt arises concerning the validity of the conclusion. Thinking proceeds as a sequence of conclusions. "All men are mortal" is itself a conclusion subject to proof and doubt; but in actual thinking when the conclusion "Socrates is mortal" appears, the two premises are taken for granted. For example, I have the thought: "Socrates was a Greek philosopher. He was mortal. His death resulted from drinking hemlock." Each sentence puts into verbal form a judgment or conclusion, a certain meaning assigned to certain facts. Conclusion succeeds conclusion according to the laws of association and the *Aufgabe* of the moment. Suddenly I myself or a listener questions or doubts one of the conclusions stated. The proof offered is first a statement of a minor premise. Thus if "Socrates was mortal" is doubted, my first reply may be that Socrates was a man. If this fails to satisfy the doubter, I may either state another minor premise or go on to state a major premise, "All men are mortal." There is no one answer that must be given in reply to doubt, because any proof is valid that allays doubt and secures belief in the mind of the questioner. Therefore the premises that will satisfy one person may not satisfy another. Thus, according to the manner of individual with whom we are dealing, we might have proved Socrates mortal by citing any of the following judgments: (*a*) He lived about 2,000 years ago. (*b*) Windelband's *History of Philosophy* says that he is dead. (*c*) All of the histories of philosophy agree that he is dead.

Let us take another illustration. If the statement (conclusion) that "honesty is a virtue" is doubted, it will take one line of premises to prove it to a young American, another to an adult American, and still another to an uncivilized man. Proof must always be approached from the doubter's point of view and will vary accordingly. The syllogism, therefore, is essentially an instrument of proof and of thought organization, not a mode of ordinary thinking.

Deduction and Induction.—The logician divides thinking into two forms, deduction and induction. The former proceeds from the general to the particular, being the subsumption of particular instances under established general principles. The syllogism is its type. Inductive thinking proceeds from particular to general, consisting in the formation or establishment of general principles. Concept formation is a typical case. The concept "mortal man" is built up from a large array of experiences with men each of whom has proved mortal—a process of induction, which may also be termed one of habit-formation. Once the habit or concept is formed, I proceed to apply it to specific cases. Each man is classified or interpreted as mortal—a process of deduction and also a process of habitual response. Both activities are constantly and simultaneously present in the organism, for each conscious state and each motor response is alike a case affecting habit-formation and a case of the application of a habit already formed.

This last point may well bring our account of thinking to a close. In the process of thought the organism has its most variable and plastic means of adjustment, a process that cannot be distinguished from a sequence of habits and instincts integrated toward a given end plus the conscious concomitants of such a sequence. Thinking, however, is to be set off from an instinctive sequence by virtue of the fact that it is not determined chiefly by heredity. We can regard instinct as the conservative racial solution for problems that arise, and thinking

chiefly as the individual's own contribution toward his preservation.

The "individual" of whom we speak, let it be remembered, is a most complex organism certain to have its relative place in the population on the basis of its mental ability; certain also to retain traces of its infrahuman ancestry and of its life with other individuals of its kind; and, because of the complicated environment in which it lives, certain to be subject to abnormalities and disease. This individual, the subject-matter of psychology, is not a cold and abstract entity, but is nothing less than that fascinating friend, the human nature in each of us.

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